THE

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THE

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THE LABOUR PROBLEM—A SUGGESTION.

AT this season of the year it is usual for large numbers of the people of this country to fall into the lowest depths of poverty and distress. The present year is exceptional only because the distress is of more than ordinary intensity, and it extends over the country perhaps more widely than has been the case for many years.

Sir Hiram Maxim points out that the sparrow is one of the most perfect of living creatures, of which there are many more in October than in March. Why this is so, is that winter thins their numbers. Only the most hardy survive to propagate their species. Man, on the other hand, however degenerate, is preserved alive, being of more value than many sparrows, and so it comes about that thousands of weakly degenerates are kept alive to multiply, and the burden of keeping them alive falls on the shoulders of those but little higher in the scale, and these, in turn, are dragged down to the same unfortunate level.

So altruistic have we become, that we submit to the more or less active endeavours whereby foreign Governments deliver their starving, diseased and criminal poor to degenerate upon our shores. We make no protest. We at once set to work to feed and clothe them. The best of them go forward to America, and the hopeless ones are left to our charity, which, in helping the stranger, allows our own people to perish, or drives them away from the shores of their native land. The East End of London is a huge plague spot of foreign refuse. If anyone disbelieves this, let him walk from Bow to Aldgate Pump and he will see that Whitechapel and the Mile End Road—the best parts of the East End—are full of sallow, low type foreigners, whose manner of life is that usual with the poor of Germany and Russia. He will begin to have some inkling of the wickedness of allowing England to be polluted by such an immigration, and he will realise how very far along the road of national decay we have already gone. Other plague spots are to be found in Leeds, in South Wales, in Lanarkshire. At one time this degeneracy was confined to London; to-day it is infesting the land from numerous centres. It is not our purpose in this article to suggest remedies. Last year the Government attempted to deal with the alien plague, but, unfortunately, the Bill was blocked by the Opposition.

This foreign invasion is a serious and growing danger. Another danger known to everyone is that of the insobriety of the people. Taking the majority of the working classes, whether earning only £1 a week or up to £6 and more, it is practically general that one week after being out of work they are in some trouble, and are soon *in extremis* for the necessaries of existence, owing to extravagance and drink. This is an evil that could be dealt with, were we not so averse to curtailing the liberty of some for the general benefit. We compel sober clerks, earning small incomes, to

maintain drunken puddlers earning large incomes. This also is a matter that could be cured by drastic legislation, and for our part we see no harm in exercising compulsion upon those who will not master their own vicious selfishness.

But we have suggestions to make for the amelioration of the general distress which recurs every winter. The present method is little else than so much waste of money. It is included in the general term of relief works, which are usually works that are not required, and are mere temporary palliatives which load up the rates, and leave the community less able every year to cope with its winter carnival. We use this last word in a very real sense.

Thoughtful men have for years pointed out that our internal systems of communication are sadly behind the necessities of the country; that our canals are reduced wilfully and purposely to mere shallow troughs incapable of serious use. We have already pointed out that in a little country like Belgium, canals are considered small which will only take barges of 300 tons capacity; that many of them will take vessels of 1,000 tons; and that large ships can get right up to Ghent.

It is said that our own paltry canals are so much in the hands of the railways, that it is hopeless to attempt to remedy the present lamentable state of affairs. To this counsel of despair assent cannot be given. The railways are privileged monopolies, holding their rights and duties by the will of Parliament for the good of the community, and not that the community shall suffer in order that narrow-thinking directors may give play to their mistaken policy of raising the cost of carriage. We have no animus against railroads, as such, but rather believe that they would share in the enhancement of prosperity that would be brought about by a good and well-managed system of canals. Even were the railways, with their weight in Parliament, to hold to their prey, it can be truly said that the existing canals could not be, in any degree, utilised. Not a bridge, over or under, could remain useful on a regenerated canal. The volume of the existing channels is too small a fraction of the excavation necessary to make a modern canal to be worthy of a moment's consideration. The lines of route are alone of any real value; but even these are not so much superior to other routes as to be indispensable. At the same time, we hold that Parliament has the right to expropriate the present canals at the scrap value to which they have been reduced, in defiance of the public good and convenience. The construction of such modern canal systems as we have in mind could be undertaken as part of a grand national scheme of employment. Our climate is such that the work need not be done necessarily in summer.

With the aid of electrical power an immense traffic could be carried on the new canals, at the lowest rates, and the expenditure of public money would at least bring into being something of permanent value, very different from the extravagant luxuries on which many boroughs have spent money which they could ill afford. Take West Ham as an example. Overloaded with a rate of nearly 10s. in the £, West Ham has tramways and costly electrical undertakings and piles of unnecessarily expensive buildings, and, as recently shown, some 40,000 people who cannot keep a roof over their head, who have not the penny to pay for a ride on their expensive cars, and who are dependent for food on 140,000 other people little better off than themselves.

Meantime we have few canals, because the railways do not wish us to have them. Places like West Ham buy foreign-made goods because the railways help them to do so by preferential rates on foreign goods. Canals can, and abroad do, carry rough goods very much more cheaply than railways. The Belgian Government, which owns railways, also makes canals to compete with them, and finds it to be to the advantage of both, and also to the public advantage.

As an example of what a canal will do, we may cite the Manchester Ship Canal. In the years 1878-9 half the warehouses in Portland Street of that city were tenantless. Manchester was decreasing in every sense. The Canal was made, and the opposition of the London and North-Western Railway and of the Liverpool Dock Board was probably responsible for the cost being several millions sterling more than it should have been. The railway company averred that the Canal could not be made, and if made would not be used. Yet before it was finished they built branch lines to enable them to use it. It was built, and though sadly hampered in use from lack of capital, its results are manifest. South of Portland Street have grown up many streets of fine warehouses, where in 1878-9 were dismal slums. Liverpool itself has experienced benefit, and the whole of South Lancashire has profited from the construction of the Canal, in spite of every difficulty.

For several years now, in addition to the waste of the war, which is largely responsible for the exceptional poverty of the present winter, the resources of the country have been expended on unremunerative undertakings, set afoot in many cases by the representatives of the people in local government of such places as distressed West Ham. The men who undertake affairs of local government have usually an insufficient grasp of business and financial principles, and do not understand that money spent in unremunerative luxury only serves to lay permanent loads upon the ratepayers, and does not earn profits.

The population of the country has been increasing; meantime its savings and surplus capital have been expended on that which is not profitable. Industrial undertakings have starved. With good canals, trade throughout the land will be greatly helped forward, and profits in all businesses will be improved. We hear much of the artificial stimulus to be derived from tariffs. Such artificial aid would be on the lines of galvanising a strangling man who wants circulation only. It is this circulation that is needed to help trade, and the construction of such a circulatory system would, if properly thought out, find means of relieving periods of acute poverty and steadying employment.

The Fog Nuisance.

DESPERATE diseases need desperate remedies, and those who survived the discomforts and delays of last week, we are sure, would welcome any cure, no matter how desperate, for the wretchedness then endured. In our extremity, Sir Oliver Lodge comes to our aid, and cordially invites "municipal or other engineers" to Birmingham, where he will show them his fog-dispelling apparatus at work.

We hardly need say that we heartily wish success to Sir Oliver in his praiseworthy efforts to clear the air. Though, as he himself says in a letter to the *Times* of 23rd inst., the electrical method of dissipation is not the right remedy for a state of things due largely to the use of crude fuel, imperfectly consumed, nevertheless while awaiting reform we must do what we can to mitigate the nuisance; and as he goes on to say that the cost of the electrical energy required is insignificant, compared with that now expended in artificial illumination, there seems to be no reason whatever why experiments should not be carried out on a large scale. Not even the supply companies would suffer were the success of the system demonstrated, for the apparatus could only be utilised in important thoroughfares and at busy crossings; moreover, it would only clear the air, and would be inoperative, besides unnecessary, in the case of a high fog, brooding over the house tops. But even if this were not the case, the greatest good of the greatest number must prevail, and it would be a triumph indeed if Electra were to subdue the fog demon and sweep away the smuts with the brush discharge.

THE SUCTION GAS PRODUCER.

By AN ENGINEER.

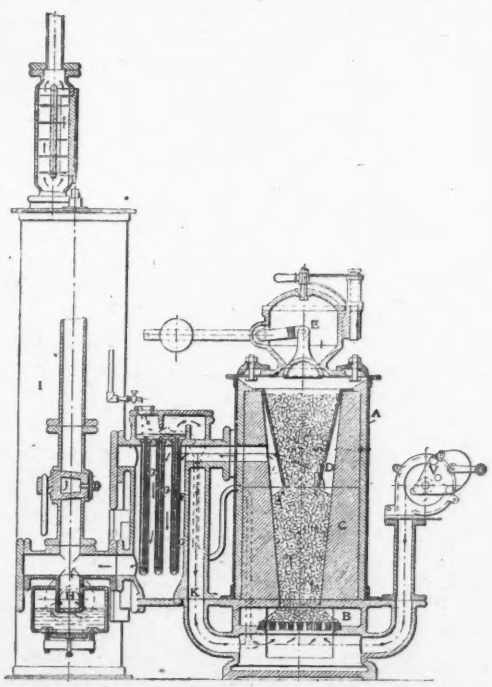
The development of the suction gas plant marks a most important epoch in the history of generators of gas for use in internal combustion engines, as no external source of power, no steam boiler or gas holder is employed, thus reducing the first cost and rendering the apparatus of small dimensions, with a small number of parts.

The evolution of the gas is induced by the motion of the gas engine piston on its charging stroke, and there is no steam jet or blower necessary; the quantity of gas produced also depends solely upon the requirements of the engine. The efficiency and economy are increased by the proportion of water gas formed through the addition of water vapour to the air supply, and the grate and fire are by its means prevented from reaching too high a temperature, thus reducing the lossses due to the sensible heat of the gas, and radiation, as well as the formation of clinker and destruction of the grate bars.

There are various types of suction producers now on the market, more or less similar to one another in most respects. The generator usually consists of a metal casing, cylindrical in form, and containing a fire-brick lined combustion chamber, above which is a hopper capable of holding a quantity of fuel. The gas outlet is usually situated about half-way up the casing.

The gas, as it leaves the producing chamber, has a somewhat high sensible temperature, and this is employed for generating steam, thus serving two purposes:—the reduction of the temperature of the gas, and the provision of water vapour to be carried by the ingoing air supply to the hearth, so as to increase the internal economy of the generator by adding water gas to its product.

There are two systems of "cooling and evaporating"; in one the hot gases are made to pass through a small tubular evaporator attached to the generator casing; in the other, the



A, Shell; B, Grate; C, Lining; D, Hopper; E, Charging Valve; F, Boiler; G, Field Tubes; H, Water Seal; I, Scrubber; J, Air-Cock; K, Air and Steam Duct; V, Hand Blower.

Bollinckx Gas Producer.

boiler is arranged round the generating chamber itself, the latter method having the advantage of reducing the temperature of the fire, and the loss due to radiation from the surface of the generator and the evaporator.

In either system, the gas is next made to pass through a small scrubber, which consists of a separate chamber filled with coke, and provided with a water-spraying pipe. The quantity of water required depends upon the temperature of the gas entering the scrubber, as it is essential that the gas should be cooled to about atmospheric temperature before being admitted to the cylinder of the gas engine.

As the Otto cycle is that most generally adopted for engines up to 100 H.P., it will be obvious that the flow of the gas drawn from the producer will be intermittent when a single engine is employed. As a suction stroke only occurs once in two revolutions, or four strokes, the entrance of air and steam is not continuous, but if more than one engine, or an engine having two cylinders, or two-cycle engines are applied, the generation of gas will be more uniform.

However, the flow of gas from the producer can be made more continuous by placing a vessel of a moderate capacity in the system between the scrubber and the engine; this takes the place of the "antifluctor" or "gas-bag" usually fitted to engines fed from pressure producers.

As the production of gas depends upon the reduction of pressure due to the motion of the engine piston on its charging stroke, it will be obvious that there must be some provision for starting up. This is provided for by a small hand blower, which is used for bringing the fire up to its working temperature. When it is stated that from lighting the producer to starting the gas engine, only from 10 minutes to a quarter of an hour elapses, it will be seen that the starting question is a matter of slight importance.

When once the fire has been properly started, it continues producing gas as long as the engine is kept running, and the volume generated is in exact proportion to the requirements of the load on the engine. Providing there is no clinker formed on the fire bars, there is no necessity to open the fire door, even when the producer is standing during meal hours, or over night.

It will be obvious that the formation of clinker will depend upon the quantity of ash in the fuel employed. Should it be necessary to remove clinker owing to the use of a poor class of coal, this can readily be done in a few minutes, or during a stand for meals at night. All that is necessary is to open the fire-door and rake out the clinker, see that the fire is again in good order, add more fuel to the fire still on the grate, and blow up for a few minutes.

As the whole apparatus when working has a lower internal pressure than that of the atmosphere, there is no danger from leakage of gas, while should there be at any time a leakage of air into the interior of the apparatus, forming an explosive mixture, the slight explosion which results has no other effect than blowing a little water out of the seal well.

A very important point about this class of producer is that it can be applied in small units without reducing its efficiency or greatly increasing the proportion of first cost; the system can therefore be applied to all engines at present running on town gas. Up to the present single producers have been designed of 100 H.P. capacity, and there is no doubt that larger ones will follow as the application becomes more general.

These small producers only cost, for fuel, from $\frac{1}{10}$d. to $\frac{1}{8}$d. per B.H.P. per hour, according to the price of the fuel, even if the size of unit is as low as 4 B.H.P.

An examination of the adjoining illustration (reproduced from our contemporary *Power*), and comparison of the system with others, will show its great adaptability to almost all power requirements. A station of 500 H.P. would have, say, six 100-H.P. producers and gas engines, which would thus provide a spare set available for taking the load of any engine that required stopping for the short time required for clinkering.

The floor space occupied by a 100-H.P. suction producer is only about 10 ft. × 3 ft., while a 25-H.P. plant, delivered and erected complete, would cost about £86, or a 200-H.P. plant about £150.*

It might be expected that by this system there would be considerable reduction in the power capacity of the engine due to fluid friction from having to draw the gas for its own use, through the producer, but this is not found to be the case. The bottom loop card taken by a weak spring in the indicator only shows about 1½ lbs. negative pressure, while a gauge fitted close to the scrubber outlet shows only a few inches of water suction.

* Mr. Hall Williams, "Gas Producer Plants for Factories," Junior Institution of Engineers, February, 1904.

THE PRODUCTION AND UTILIZATION OF OZONE.—II.

By JOHN B. C. KERSHAW, F.I.C.

The present writer, in an article published in the issue of the Electrical Review for August 19th, described and illustrated the most recent forms of the Marmier-Abraham, Otto, and Siemens & Halske ozonisers, and gave some information concerning the applications of these forms of ozoniser to industrial purposes. In the present article other forms of ozoniser that have received trial recently will be dealt with, and some details of the progress of the trials of ozone as a water sterilization agent in Germany and elsewhere will be given.

I.—Production.

Laboratory Ozoniser.—Fig. 1 shows the modified form of the Berthelot tube ozoniser, now being employed by Drs. Bone and Drugman in research work at the Victoria University laboratories in Manchester. This ozoniser consists of a U-tube formed of two thin walled glass tubes, one inside the other, their surfaces nearly touching, and sealed together at J. The outer U-tube has branches at A and B, for the inlet

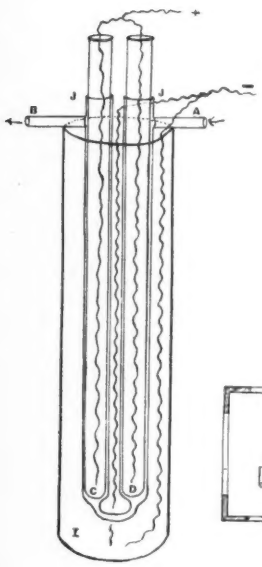
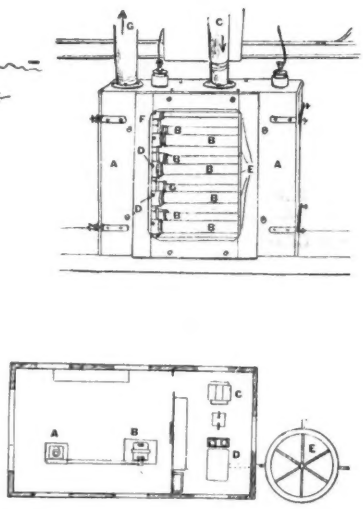


Fig 1.



Figs. 2 and 3.

of air, and exit of the ozonised product. The conducting medium is a slightly acid solution of copper sulphate, the inner tubes, C and D, and the outer thick glass containing vessel E, being nearly filled with this solution. A stout copper wire passes down each of these tubes, as shown in the diagram, and these wires are connected, as shown, to the positive and negative poles of the coil or transformer supplying the current.

At Manchester, Drs. Bone and Drugman are employing four accumulator cells, and a coil giving a 4-in. spark, as the source of the electrical energy required for their ozonisers; but a transformer could equally well be used with this form of apparatus.

The air passes along the very narrow annular space between the inner and outer tubes in its course through this ozoniser, and the yield of ozone is stated to be remarkably good, although no figures have yet been published on this point. The advantages of a liquid contact in place of metal are, that there is a more regular and silent discharge of the electric current in the space between the two glass tubes, and that the temperature of the apparatus can more easily be kept under control, a flow of the sulphate solution through the inner and outer tubes being very simple to arrange, if desired. Any number of single ozoniser tubes can also be grouped together, and for experimental work this form of ozoniser is said to be superior to any that has been yet tried. For industrial purposes, its fragile construction is, of course, a serious defect, and would probably lead to trouble.

Elworthy's Ozoniser.—Fig. 2 is a diagram sketch of the Elworthy form of ozoniser, which is also of the tube type. The square box A contains 10 ozonising tubes, B B B, each consisting of two concentric glass tubes containing a spiral of aluminium wire. The air passes into the box by the inlet pipe C, and thence into the nearer row of ozonising tubes by the inlets D D D. In passing through the annular space in each of these ozonising tubes, it is subjected to the silent electric discharge, and reaches E, containing some amount of ozone. From E it travels back by the rear row of tubes to F, and is again submitted to the action of the silent electric discharge, finally issuing from the apparatus by the exit pipe G. According to the inventor, no cooling or drying of the air with this form of ozoniser is required, as it is claimed that the rapidity of the air-flow through the apparatus is sufficient to keep down the temperature. The yield of ozone is stated to be from 58 to 70 grammes per KW.-hour, and a primary alternating current of 3·2 amperes at 130 volts will suffice to operate one ozoniser of ten tubes, as shown in the diagram, a transformer being used to raise the E.M.F. to between 11,000 and 12,000 volts. Further details of this ozoniser will be found in an illustrated article by the patentee, recently published in the *Elektrochem. Zeitschrift* for April, 1904.

The Vosmaer-Lebret Ozoniser.—The writer, in the first section of this article published on August 19th, was unable to give any details of the construction of this ozoniser, which has been used in Holland for experimental trials upon water sterilisation. Since that date the following abstract of the American patent No. 754,261 has come under his notice, and may be given here :—

Ozoniser.—A. Vosmaer, Nieuwersluis, Amsterdam, and A. Lebret, Utrecht, Netherlands. Patent 754,261, March 8th, 1904. Application filed September 11th, 1904. **The apparatus consists of a transformer, the secondary of which is connected with a condenser in shunt, while a choking coil is interposed in series in one of the branches between one terminal of the transformer secondary and one terminal of the condenser branch. The ozonising apparatus, which works without any interposition of dielectrics between the electrodes, is also connected across the conductors from the secondary. The effect of the condenser is to increase the effective secondary voltage to a higher value, chiefly depending on the relation which exists between the current passing in the shunt of the condenser and that in the ozoniser. It is stated that the two phenomena resulting from the employment of the condenser (super-elevation of the secondary tension and suppression of arcing) are intimately connected one with the other, and that the sparking produced in the ozoniser decreases in proportion to the degree of super-elevation of the secondary voltage. Thus, the more the secondary voltage is super-elevated, providing the intensity of the current in the branch of the ozoniser is low, the better will be the production of electric effluvia which require a high tension, but a small current.**—*Electro-chemical Industry*, April, 1904.

It is thus seen that the Vosmaer-Lebret ozoniser is of the type provided with a choking coil to suppress sparking in the absence of any dielectric, a type which is usually considered wasteful of electric energy when employed for large scale installations.

Goldstein's Ozoniser.—Goldstein, a German investigator, has recently discovered that it is the ultra-violet rays of light which are chiefly instrumental in the formation of ozone, and he has designed a quartz glass tube ozoniser which is said to utilise these ultra-violet rays to the fullest advantage. Two platinum electrodes are fixed in the ends of this tube, a vacuum is produced in it, and upon allowing the electric discharge to occur between the two electrodes, the tube becomes filled with the usual coloured haze. Only the ultra-violet rays of light, however, can pass easily through the quartz glass envelope which surrounds them. If the tube be now placed in an atmosphere of pure oxygen, cooled below $-100°$, almost the whole of the gas is transformed into ozone, and this condenses upon the outer walls of the quartz glass tube, as a blue liquid. Not only is the action of the silent discharge much intensified under these conditions, but the liquid ozone is more stable than gaseous ozone, and is less liable to be decomposed by the rays which produce it. The reaction, in fact, ceases to be a reversible one at $-100°$ C.

More will doubtless be heard of this method of producing ozone, since the discovery seems as though it would greatly increase the yield of ozone per KW.-hour, and thus reduce

the cost of the product. A few details of Goldstein's research are given in the *Electrical Review* (New York) for September 10th, 1904, but unfortunately the value of this reference is slight, since the original paper or article is not referred to.

The Rosenberg Ozoniser.—This ozoniser was described and illustrated in the Electrical Review of November 11th, 1904. In this type copper gauze is employed as the electrode material. The suppression of sparking in this new form of ozoniser is said to be due to the enormous number of points from which the discharge occurs, each corner of each mesh acting in this manner. An ozonising apparatus of this type contained in a box measuring 16 in. × 16 in. × 28 in., comprising three vertical ozonising surfaces, is said to possess 900,000 such discharge points—and the yield of ozone is stated to be 250 grams per KW.-hour.

If these figures bear investigation, the yield in this apparatus is a distinct advance upon that of any other form of ozoniser for which figures have yet been published, and further details of the exploitation of the patent will be awaited with interest.

The following table brings together all the hitherto published figures for the yields of the various forms of ozoniser, with the calculated cost of electrical energy, when the E.H.P.-hour is supplied at 1½d. :—

Comparative Yields and Costs of Ozone.

Form of ozoniser.	Yield of ozone in grammes per E.H.P.-hour.	Cost of electrical energy in pence.	
		Per kilogramme of ozone.	Per kilogramme of active O.
Rosenberg	184	8·15	24·45
Yarnold	175	8·56	25·68
Otto	155	9·67	29·02
Andreoli	94	15·90	47·70
Elworthy	48	31·20	93·60
Siemens & Halske	25	60·00	180·00
Marmier & Abraham ...	20	75·00	225·00

The Rosenberg ozoniser, therefore, heads the list, but the cost of the kilogramme of active oxygen by this new ozoniser is still greatly in excess of the cost by the usual oxidising and disinfecting agent — namely, hypochlorite of lime—(bleaching powder or bleach), namely, between 14d. and 17d. It must be remembered in this connection that the 24·45d. given in the above table, is the cost of electrical energy only, and that an addition of between 100 and 150 per cent. must be made to this, to obtain the total cost of a kilogramme of active oxygen, by the silent electric discharge method of production.

Gray has recently been investigating the conditions which lead to a maximum yield of ozone in the Siemens & Halske tube form of ozoniser.* He has found as a result of his investigations, that the production of ozone attains a constant quantity per coulomb of electricity employed in producing it—and that this quantity is independent of the P.D. between the electrodes. The constant for the ozoniser he used was ·27 grm. per coulomb. Gray, therefore, concludes that the maximum yield will always be obtained when the P.D. between the electrodes, is just sufficient to cause a luminous discharge in the gas passing through the apparatus.

II.—Utilisation for Water Purification.

In the previous article upon ozone, the writer referred briefly to the use of ozone for water purification at Rotterdam, Marseilles, Niagara Falls, Martinikenfelde, Schierstein and Paderborn, and promised to give more information relating to these installations in the concluding article.

Rotterdam.—The writer recently has been in correspondence with Dr. van't Hoff, regarding the proposed installation of an ozone water purification plant at Rotterdam, using the Vosmaer-Lebret ozoniser. Dr. van't Hoff states that since the date of his 1902 paper, no further steps have been taken in this matter, and the proposal, therefore, remains in its embryonic stage of development. Some particulars of the experimental plant at Schiedam were given, however, in the last article.

* *Journal* Soc. Chem. Industry, February 29th, 1904, p. 191.

Marseilles.—A description of the plant erected at the brewery of MM. Velten in this city, was published by Marmier in *L'Electricien* in 1903, and the following details are taken from that article. The ozoniser is of the Marmier-Abraham box type, the electrodes being hollow and cooled with water. (For illustration see last article.)

An alternating primary current at 60 volts pressure is employed, and is transformed into alternating current at 40,000 volts for use in the ozoniser. The air used is dried by passing over pumice stone soaked in sulphuric acid, and is forced into the ozoniser under 10 — 20 mm. water pressure.

The sterilising tower is circular, and is of brickwork, being 20 ft. high and 10 ft. in diameter. This tower is filled with flints, and the water is caused to flow down in a well-distributed manner, as the ozonised air passes up.

Each litre of ozonised air is stated to contain 6 mgs. of ozone, and 1 cb. metre of this air (equal to 1,000 litres = 6 grammes of ozone) is reported to completely sterilise 6 cb. metres of water.

The amount of ozone required to sterilise 1 cb. metre (1,000 litres) of water is, therefore, 1 gramme. A concentration of 12 grammes of ozone per cubic metre of air can be obtained, with a discharge equivalent to 5 KW. per sq. metre of electrode surface.

Lille-Emmerin.—The Marmier-Abraham system of water purification by means of ozone was installed at this place in 1898, in order to deal with the conditions caused by a severe epidemic of typhoid fever. Fig. 3 (p. 1052) is a plan of the Emmerin plant. A is the generating plant, B the dynamo, C the step-up transformer, D the ozonisers, and E the sterilisation tower. The voltage used was 30,000. A large number of medical and other reports were made upon the work of this plant, and the installation was ultimately taken over by the town authorities.

The normal capacity of the plant is stated to be 35 cb. metres of water per hour, but, if required, 3,000 cb. metres could be dealt with per day of 24 hours. The cost of treatment at Lille, for an average water, is stated by M. Marmier to be ·0045 fr. per cb. metre (equivalent to 1·2d. per 1,000 cb. ft.), but it is not stated whether this estimate covers all the charges—depreciation, interest, &c.—of the installation. The writer believes that the Lille-Emmerin plant is still in operation.

(To be concluded.)

THE RAPID TRANSIT SUBWAY OF NEW YORK.

The shallow subway system of New York was recently opened with a great flourish of trumpets. The passenger traffic at once assumed very large dimensions, and these numbers were assumed to be only a foretaste of joys to come. Unfortunately, as in all new undertakings, if we are to rely on newspaper reports, the staff was not in full working order; it were indeed somewhat of a marvel had it been so, with no actual experience of such lines to go upon.

There has been trouble in dealing with the traffic, and the trains have been unable to "run on schedule," which is phonetically equivalent to keeping time. Moreover, the ventilation is pronounced bad for there is a most serious deficiency of oxygen in the subway atmosphere. As a first result, it is said, traffic has fallen off, and passengers have gone back, or upwards, to the old Elevated Railway. Almost simultaneously with these lugubrious reports there appears a report in County Council orange, by Mr. J. Allen Baker, the Chairman of the London County Council Highways Committee. This report of 49 pages is elaborately got up, and full of pictures of the New York subway.

In view of their attitude towards tramways generally, and the understood relation of the London County Council towards shallow subways in particular, this report may be considered somewhat in the light of a piece of special pleading for the shallow subway system for London.

We are not quarrelling, by any means, with the shallow subway system; indeed, we think well of it. But we cannot refrain from asking if it is not a fact that there would have been a length of shallow subway in London this dozen years had not the County Council and others slaughtered the Bill which was introduced in Parliament in 1889? Unless our memory fails us, one of the first acts of the newly-constituted County Council was to appear, in the person of the late Charles Harrison, as a witness in opposition. This gentleman gave opposing evidence on May 9th, 1889, as chairman of the Parliamentary Committee of the L.C.C.

In that proposed London subway all the main features of the New York scheme were outlined. The streets were to be cleared of their mixture of earth and pipes, and covered with a steel and concrete roof carried on steel posts. Entry to the stations, which were to be at Holborn Circus, Museum Street, Piccadilly Circus, St. James's Street, and one other, was to be by a shallow flight of stairs into stations in the line of building. All pipes were to be placed in galleries, and, generally, this trial line with its electrical equipment would have been at least a useful experiment. The scheme was well backed financially, and it was thrown out of the House by the aid of the County Council, whose Highways Committee's chairman now sends in a glowing report on a similar undertaking in New York. It is curious how attractive foreign undertakings may appear to a municipally minded traveller.

Owing to delays in opening, Mr. Baker was unable to see the line in actual operation, but he has secured numerous particulars and many photographs, and he appears to have appreciated what is undoubtedly a piece of magnificent engineering work, much better than did the Council of 1889 the scheme then submitted.

We need not trace the early history of the New York undertaking. The first point to be noted is that though the power houses are taxed like other real estate, the subway itself, the franchise, and the equipments and rolling stock are untaxed. The subway itself belongs to the City; the other items are the property of the contractors. The cost was not to exceed £7,000,000, and the Southern terminus was, therefore, fixed at the Post Office, which is quite a long way from the extreme point of the City. At 104th Street the line branches into two, the West and East side, two track lines which have been partially extended to have three tracks. The total mileage in single track is 62, of which length 6·7 miles are four-track, 6·7 miles are three-track, and 7·7 miles are two-track roads, making a street mileage of 20·81 miles.

From the views of the line given in the report, one reason for the bad ventilation becomes perfectly clear. Only steel pillars stand between the different tracks. The subway is very wide, and each train only fills a small portion of it, and can therefore have very little effect upon the ventilation.

In the proposed London subway of 1889 there was to be a thin non-resonant partition between the tracks and the trains would have compelled ventilation. The report before us speaks of the New York subway as being well ventilated, but Mr. Baker wrote this apparently before the line was at work, for he did not stop to see it opened, and he could not possibly judge of ventilation in a place where there was nothing occurring to call for change of air. There is, however, nothing to prevent the placing of the necessary partitions from column to column, and so greatly facilitating the air expulsion, even at some increase of train resistance.

Mr. Baker not inaptly refers to the arched tunnel type of railway, like the London Underground, as possessing the advantages of neither the deep tubes nor the shallow subways. From the street surface to the roof of the subway the minimum depth is 30 in. The street is thus merely a roof over the subway, such as was laughed at by the late Samuel Pope, Q.C., as making a drum of Piccadilly.

Though New York is comparatively a city of yesterday, the complication of pipes and other buried lines of communication was a very serious matter to deal with. The report gives very little information as to how pipes and sewers were dealt with, but from the pictures it can be gathered that in places large pipes were taken care of over the subway roof by sub-division into several smaller pipes. But no full scheme of pipe galleries seems to have been undertaken.

The power house is distinctly American. In the basement of the boiler house are ash conveyors. Next above are the boilers, above which again are the economisers, and above these again the coal bunkers.

The condensing plant and other auxiliaries are placed between the boiler house and the engines, which consist of pairs of compound engines with horizontal H.P. cylinders working on the crank-pins of vertical L.P. cylinders, a sort of modification of the old Lancashire practice.

The five brick chimneys are in line down the middle of the boiler house, but they are carried on steel column framing 76 ft. high, and this leaves open the space below, which would otherwise be occupied.

The most costly of the four-track work absorbed £800,000 per mile. Two-track work, exclusive of stations, averaged £265,000, and elevated portions £105,600, also exclusive of stations. When the whole system is complete to the outskirts of Brooklyn, it will be possible to travel 18 miles for the customary 5 cents.

A useful idea in station construction has been to make each station of individual aspect, so that a passenger can recognise his own particular pattern—a departure from standard patterns which is certainly excusable. The different effects have been obtained by variations in the lines and panellings of the glazed brickwork. Nor have they scorned a *jeu de mot*, for each pier panel at Astor Place station carries a beaver in bas relief.

Taken in all, this New York subway is a fine piece of work, and it should not be difficult to cope with the reported ventilation troubles. The wonder is that this was not foreseen and suitably provided against after the examples of London's troubles.

SOME ANOMALIES OF MUNICIPAL TRADING.

By Y. Z.

II.

Many local authorities regard electric lighting as a kind of birthright. Consequently the ambitious councillor, anxious to be associated with initiation, scans the tabulated accounts of municipal electric lighting undertakings (how descriptive this word really is), and shows by averages, based upon the misleading accounts of other towns, that such an enterprise should yield a profit after the first year. He does not anticipate a large profit in the second year, but sees what a splendid asset would be secured to the ratepayers, &c.

He sees no reason why the project should not be much more successful under the enlightened management of his colleagues and himself, than other similar undertakings elsewhere. The prospect is alluring, especially to those councillors who publicly talk in thousands, and privately deal in pence; and it is decided to apply for a provisional order. The question then arises as to who shall prepare a scheme. The ambitious initiator, having read the tabulated accounts, and being able to talk about units and load factor, fears not to walk, and suggests the economy of instructing the surveyor to do it—with a hint as to his own knowledge. This hint defeats it own ends, for a jealous colleague, not having studied the tabulated accounts, has a chill doubt, and, as an amendment, proposes "that an expert be instructed to prepare a report at a strictly nominal fee, to be merged into general fees in the event of his scheme being approved of and carried out by the Council."

After a fierce discussion and accusations of extravagance, the amendment is carried and an expert appointed. The question of general fees arises, and it is decided provisionally that the expert is to receive a percentage *on the amount spent*.

Now we look with pride on our consulting engineers, and although we do not consider the effect of their conservative prudence on our industries, yet we justly regard them as being on the same ethical plane as our judges; but they are only human, and when encouraged by their employers to make the lighting a credit to the town with all economical appliances and ample facilities for extension, who shall blame them if in the circumstances they reflect their employers'

views in their report, and, in doing so, over-estimate the revenue, and, in fact, place the venture on an entirely fallacious capital basis, especially as municipalists are in the habit of talking of the profit to be derived, and in the same breath, stating that a municipality does not want to earn large profits like a company.

The advocates of municipal trading maintain that a local authority is in a better position to trade than a limited company, because it can borrow at a comparatively low rate of interest. They point at the 5 per cent. offered to debenture holders, the 6 per cent. to preference shareholders, and to the inducements offered to ordinary shareholders to subscribe, and they say that they can borrow at about 3½ per cent. Councillors almost claim personal business capacity because of this borrowing facility, and rather despise capable business directors on account of their difficulty in raising capital. But what would these councillors say of the man who, without necessity, mortgaged the estates of himself and his heirs with the possibility of gaining 1 or 2 per cent. more interest than he has to pay, and the absolute certainty that he and his heirs will have to make good all losses?

If these councillors were directors of a company whose organisation was that of a local authority without rates to mortgage, but only the security of the undertaking to offer, it is doubtful whether any subscribers could be found.

As a rule a local authority consists of about 18 elected members. These members, although they may be unanimous as to the desirability of trading, may differ materially in their views as to management and policy. Consequently their decisions are often vague compromises, entirely devoid of that strength necessary for successful trading. Their usual panacea for loss is extension, and when, after having bought some experience at the expense of others, the loss becomes unbearable, their places are filled by others without experience, who make promises which cannot be fulfilled.

REVIEWS.

The Electric Furnace. By Henri Moissan. Translated into English by A. T. de Mouilpied, M.Sc., Ph.D. London: Edward Arnold. 1904. Price 10s. 6d. net.

One must view with mixed feelings the appearance, seven years after the publication of the French original, of an English translation of Moissan's own account of his famous researches. Of course, it may betoken the fact that the increase of general culture among our men of science and engineers has rendered an English version of a French work a luxury rather than a necessity; or it may betoken the continued existence of the national faults of supineness and indifference that we would fain believe we had become fully alive to, and had shaken off. Let us be charitable, and believe that the former is the true explanation of the tardy appearance of the book now before us, and if, in the eyes of some, such a belief amounts almost to credulity, let those prophets of evil comfort themselves with the knowledge that it is only a few weeks ago that the authorised American edition of "Le Four Electrique" was published, and that we may even score a point over our friendly rivals, inasmuch as Mr. Edward Arnold's edition is, of the two, decidedly the superior. The translation on the whole is good, but it is too literal, with the result that there is often some sad confusion of tenses, otherwise there is little adverse criticism to make; the bold and excellent print is as much a credit to the printers' art, as it is a soothing delight to the readers' nerves, and this is worthy of all grateful recognition.

The advances that have been made in the applications of electric furnace methods to industrial operations in the 12 years since Moissan began his laboratory researches are truly remarkable, and it is no exaggeration to say, it is these very researches of Moissan that have formed the starting points for, and given an impetus to, many of the commercial processes now familiar to all technical men. No progressive chemist, therefore, and no broad-minded electrical engineer who is really interested in all the possible applications of the agent which it is his business to produce and supply, can afford to be ignorant of investigations of such fundamental importance. Within the last few years the preparation of calcium carbide, and of the more important ferro-alloys, such as ferro-chrome, ferro-silicon, and ferro-titanium, to mention only a few of the reactions first studied by Moissan, and of carborundum and graphite (in connection with which the name of Acheson should also be mentioned), have passed from the laboratory stage into industrial processes of considerable magnitude. Moreover, there seems little doubt that we are now on the eve of witnessing a revolution in the manufacture of high-grade and special steels—and, perhaps, under certain conditions, even in the smelting of iron itself—due to the introduction of these same electric furnace reactions, the principles of which can nowhere be so thoroughly and scientifically studied as from the pages of Moissan's treatise.

The book is divided into five chapters. In the first chapter are described the various types of furnaces used by Moissan in his researches, and in this connection he is careful to point out that previous workers (such as Despretz, and Siemens and Huntington, "to whom we owe the first practical electrical furnace") have used the electric arc to produce high temperatures; but he, the author, has made use of the heating properties of the arc alone, leaving aside the purely electrolytic action, and has devised a simple and practical apparatus by which chemical reactions at temperatures probably exceeding 3,500° C. can be studied with ease. The rest of the chapter is devoted to a study of the crystallisation of certain oxides, and the fusion and volatilisation of the most refractory metals and oxides, such as magnesia, lime and silica.

The second is a most important chapter, and contains an account of researches on the different varieties of carbon—amorphous, graphitic, and the diamond—including the famous research on the artificial preparation of the diamond, which, it will be remembered, Moissan succeeded in producing by plunging into molten lead, and thus suddenly cooling, iron at 3,000° C. saturated with carbon in the electric furnace.

The third chapter deals with the preparation and purification in the electric furnace of chromium, manganese, molybdenum, tungsten, vanadium, uranium, silicon, aluminium, and other important elements and their alloys—particularly ferro-alloys—and is full of valuable information and suggestion. When it is mentioned that some of these metals had never before been prepared in the pure state, while others had never before been seen, excepting in the form of powder or minute globules, it will be realised what a powerful engine of research is the electric furnace, and how great a debt is owing to Prof. Moissan, who, perhaps, more than any other man, has proved how valuable and indispensable it is to the modern scientific metallurgist.

The fourth chapter deals with the preparation and properties of the carbides, of the alkaline metals, rare earths, iron, and aluminium, and of some borides and silicides. Particularly interesting is the description given of calcium carbide (which Moissan himself first prepared in 1892) and the impurities which it may contain. The short sections which follow, on the metallic phosphides and arsenides, and the whole of chapter V., which outlines the author's and his pupils' recent researches on carbides, silicides and borides, do not occur in the French edition; the last chapter, in fact, having been specially written for the present purpose. An index—lacking in the original—has wisely been added.

It can be imagined from this slight sketch of Moissan's classic work, that there is hardly a page of it which is not crowded with interest, and hardly a section which does not teem with suggestion, and if the coming of this English edition of the book has been so long delayed, we may still be thankful that it has come at last, and come in a form which it is pleasure to handle and a delight to read.

Die Elektrischen Anlagen der Schweiz. Vol. I. Die Elektrisch betriebenen Strassen-, Neben-, Berg- und Vollbahnen. Edited by S. Herzog. Zürich: Albert Raustein. 1905. Price M. 18.

This is a magnificent work of 400 pages, printed on excellent paper, and illustrated with no fewer than 533 figures, many of them on folded plates. It contains detailed

descriptions of 43 electric railways of Switzerland, of which six are operated with polyphase current, and the remainder with direct current; the experimental single-phase system of the Oerlikon Co. is also described. Of these installations the majority are, of course, tramways, about half of which, however, are interurban in character; but two main line railways (that of Burgdorf-Thun, worked with three-phase currents, and that of Freiburg-Murten-Ins, with direct current), and a full-gauge railway (Chavornay-Orbe), are included, besides several mountain railways.

The descriptions are exceedingly thorough; not only are drawings and plans given, in addition to photographic illustrations, but also diagrams of connections and detailed calculations in some cases are included. It follows that a vast amount of technical information on all points connected with electric traction is contained in the pages of this compilation. Whilst it is true that much of this information is mainly of local value, it is equally true that a very large proportion is of interest to electrical and tramway engineers in all countries, embodying, as it does, the experince of the leading Swiss engineers, whose admirable achievements have placed them in the front rank of technical skill and enterprise. The description of the Oerlikon single-phase system, in which a motor-generator is carried on the locomotive to convert from A.C. to D.C. for the driving motors, is of special interest, though the introduction of satisfactory A.C. motors has deprived it of most of its importance.

The work is certainly one of great value as a reference book. It will be followed by a similar compilation relating to the lighting and power installations of Switzerland, which may be trusted to be of equal excellence and interest.

Preliminary Conference at Berlin on Wireless Telegraphy (August, 1903). Translation of the *Procès-Verbaux* and *Protocole Final*. By George Neilson. Officially accepted by H.M. Postmaster-General. London: George Tucker. Price 8s. 6d. net.

By this time most of us are familiar with what was said and done at the Berlin Conference a year ago, and as we turn over the pages of this book, we are inclined to ask: "*Wer reitet so spät durch Nacht und Wind?*" Is it expected that the same subtle agency that disposes of space, plays similar tricks with time, so that a year is but as yesterday? It is, perhaps, more generous to suppose that the unique character of the Conference rendered it desirable to set forth the proceedings in standard form, and in plain English. The proceedings certainly contain many particulars of considerable interest to cable companies in regard to conventions, and they give the reader an insight into the various international problems which beset the question of space telegraphy. Two circumstances, however, have arisen since the Conference, to render these grave deliberations curious reading. The first is the decision of the Russian Government in reference to wireless telegraphy in war. The second is the Parliamentary Bill for the regulation of wireless telegraphy in this country. In the circumstances, it looks rather as though the efforts of the Conference upon a subject unripe for discussion had been thrown away, and we are inclined to think that the same criticism applies to the English Bill. If in times of peace we cannot syntonise or easily localise, and if in times of war the apparatus is declared contraband, what conventions are worth consideration? In times of peace, absolute freedom to experiment must be allowed, or methods of syntony will never be discovered; the common rules of courtesy can alone enable operators to get their messages through. In times of war, the nation that commands the sea will also have the best of the ether. It would be just as reasonable to legislate about the use of the heliograph, or the telescope, as it is to hold conferences and draft bills restricting the use of coherers—it is legislation without a chance. For the police it offers difficulties far transcending their ludicrous efforts at speed measurements of motor-cars. The book itself is well printed, and is excellently rendered into English. As it is presumably intended for reference, it would have added to its value if the author had provided an index.

Electro-Chemistry. By R. A. Lehfeldt, D.Sc. Part I.: General Theory, including a Chapter on the Relation of Chemical Constitution to Conductivity, by T. S. Moore, B.A., B.Sc. London: Longmans, Green & Co. 1904. Price 5s.

This is the second volume of the series of "Text-Books of Physical Chemistry," which are now being issued by Messrs. Longmans, Green & Co., under the editorship of Sir William Ramsay. As will be seen by the title, the subject of electro-chemistry has been cut in two, the present volume dealing with theory, while practical electrolysis, primary and secondary batteries, &c., are to be dealt with in a second part. Part I. consists of a closely-printed book of some 270 pages, and divided into three chapters. The first treats of the relationship between quantity of electricity and quantity of chemical action, and the third describes the relationship between electromotive force and intensity of chemical action, both of these being written by Dr. Lehfeldt. The second is written by Mr. Moore, covering the relationship of chemical constitution to conductivity. The volume strikes us as a very comprehensive, and fairly lucid, presentation of modern views upon the theory of electrolysis, a subject which still offers difficulties and obscurities to the student, and one which perhaps does not interest as many chemists and electricians as it should. That the book is "up-to-date" is shown by the foot-notes, where references to the journals of the current year may be found. Chapter I., which we have read most carefully, contains more so-called "printers' errors" than we may reasonably expect to find in a volume of this character; but in other respects it is undoubtedly a credit to authors, publishers and printers.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Nernst Lamps.

In 1902 improved lighting at the least expense was required in a church already possessing its own plant. With the latter I had nothing to do, being told the available output at a given nominal voltage, and that all was in good order. A Nernst was proposed, tried and found satisfactory, but the burners went. More lamps were added and found pleasing, but still burners failed. A guarantee was requested, but I advised that the voltage should be kept more regular, and not exceed a certain maximum. In the end more wiring and lamps were installed. The burners still gave trouble, and I continually made suggestions for the regulation of the voltage, but could get no satisfaction; and at last, one Sunday evening, the current became gradually and beautifully less, and the lighting failed so far that the congregation had to sing a hymn they all knew and go home. Thereupon I was arbitrarily kicked out, and have been unable to get any settlement of account. I have since been informed that my successor was in the same predicament with regard to the lighting, and that if I could get him to finish his work, our accounts would be gone into together.

A plant may be run by its owners in any manner they prefer, so long as no injury happens to others, but if they fail to observe reasonable conditions for the operation of the lamps used, neither the Nernst nor any other lamp, nor the fitter should be in any way responsible.

R. Pippette.

London, S.W., *December 21st*, 1904.

We beg to heartily endorse the remarks of Mr. Henry Joseph, in your issue of the 23rd inst., *re* Nernst lamp burners, and also Luna burners. Our experience coincides with his in every particular. With regard to the remarks of "R. W. S." in the same issue, and of "S. W. W." in the issue of the 16th inst. *re* voltage, we have constantly used 250-volt Nernst lamps, on a nominal voltage of 240, and have at times tried 260-volt lamps on the same circuit,

but have not found a marked difference in the lives of the burners, but we find from our books that we replaced more burners in November alone, than in the months of May, June, July, and August together, which, in our opinion, points to the climatic conditions as the chief factor in the control of the lives of burners.

We should like to make a few remarks in reply to Mr. Stephen M. Johnstone, upon the subject of the hawking of lamps, &c., at impossible prices. In this locality we have very little trouble with the class of hawker mentioned by that gentleman, as we found that they cut their own throats long ago, but we find that many customers, after their places have been fitted up by us, go direct to the wholesale houses, and get the same discounts as we should ourselves. This is particularly true of the lamp mentioned, or rather described by your correspondent, as to our sorrow we know that a one-time customer of ours bought some dozens of them the other day in that way. Where that is done, the contractors have it in their own hands to remedy the fault, which could best be done by boycotting those houses which supply goods in the manner we have described.

Suburban Contractor.

Contractor v. Hawker.

I have been greatly interested in reading the letter of Stephen M. Johnson in the current issue of the Review, and quite agree with him as regards the cutting of prices and the evils which must result.

A few months ago I introduced to the notice of a shop-keeper in a neighbouring town the B type Nernst lamp, and quoted him the list price of 5s. each, whereupon I was informed that he and several others had purchased, from a hawker, some of these lamps at 3s. 5d. each. I afterwards secured some of these lamps from the firm at Liverpool that had sent their men round with them, and in the majority of cases found that there was something faulty with them, either in the body or cut-out coil. I returned several of these to them, asking for replacements, but from that day to this, have heard nothing from them. I believe that since then the patentees are making efforts to stop these practices. But I would point out that only last week I had an instance of these lamps being sold at 4s. 6d. each by a certain London Stores, and in order to secure the order, I had to let my customer have them at this price.

There is, however, another side to the question. Why should manufacturers in many cases try to do without the contractor, and quote direct to the consumer, and even send their traveller round? In lamps especially, I find it almost impossible to get a fair profit from large consumers, such as hotels, hydros, &c., as they can purchase direct from many makers at almost the same price as myself. Only this last summer I have lost two large orders through this, the price quoted being only the same as, or only ½d. above, that which I should have to pay.

I have endeavoured to do business with the mines in this district, but find that except in cases in which I hold special agencies, the game is not worth the candle, as the majority of them are able to deal direct with some manufacturer, and I cannot quote a price which, after paying office and travelling expenses, would leave me any profit. Mind you, I do not condemn all manufacturers, as many of them are perfectly loyal and refuse to supply direct, and refer their inquirer to the nearest contractor that deals in their goods, and I have secured several orders through manufacturers.

But I ask with your correspondent, is the general condition of things fair that the pushing contractor who spends so much of his time endeavouring to obtain business, should find that it has slipped from his grasp by reason of the cutting hawker or the direct-dealing manufacturer? I conclude, as he has done, "It is high time something was done to put things on a proper basis."

H. Willoughby Lance.

Llandudno, *December 26th*, 1904.

Regarding Rotaries.

With reference to running rotary converters and synchronising them—in an article on rotaries, which appears in a new book on electrical practice, the following method of putting rotaries on is described amongst others:—

The machine is run up as a D.C. motor until a little above synchronous speed, then the shunt field is broken, and the A.C. switch put in the field, being replaced when the A.C. amperes come down to a known low value. The words are not exact, but as near as I can remember.

Does anybody know where this method is usually practised, and is there any difficulty with it?

Is the armature current allowed to remain on after the field is broken? The paragraph does not say. If the current is off both the armature and field, there will be no difference between the way described above and the ordinary method of starting up on the three-phase side, except that the rotary cannot pick her field up the wrong way round, their almost invariable custom when wanted in a hurry, and will not take such a large starting current, which, though having a low power factor, rather plays up the volts.

On our rotaries we have a small starting circuit-breaker, 600 amperes size, in series with the starting resistance, which is automatically tripped by a catch on the low tension A.C. switch when it is closed.

We generally run up on the D.C. side; the shunt field is not broken by the starting C.B. being tripped, as it is taken separately from the bus-bars when starting up.

Balderstone, A.I.E.E.

Re 6,500-volt Switchgear.

May I remind those who heard Mr. Andrews's reply to the discussion on his recent paper that his reference to 9-in. panels as having been advocated by me three years ago was somewhat misleading? The Ferranti 6,000-volt generator switches exhibited and described at Owens College at that time were not fixed in 9-in. panels, but in 12-in. cellular panels, whereas the centres per phase on the 6,500-volt switches now shown by Mr. Andrews are only 8½-in. apart, or actually less than those which I am said to have advocated three years ago for cellular panels, notwithstanding the fact that there are parts of differing potential exposed within these narrow limits (8½-in. centres) without any insulating shield between them to reduce the risks of shock and breakdown.

Henry W. Clothier.

Eccles, *December 28th*, 1904.

The Cult of the Marine Engineer.

THE TWO CULTS.

(With apologies to Rudyard Kipling, Esq.)

"This ditty is a string of lies,
But how the deuce did Gubbins rise?"

Potiphar Gubbins, E.E.,
Stands at the top of the tree,
And I muse in my bed on the reasons that led
To the hoisting of Potiphar G.

Potiphar Gubbins, E.E.,
Is many years junior to Me;
Each connection he makes either burns out or breaks,
And his work is as rough as he.

Potiphar Gubbins, E.E.,
Tipples when on the T.T.,
And I can't understand why you gave him your hand
Lovely Mehitabel Lee.

Potiphar Gubbins, E.E.,
Is dear to the Powers that Be
For they bow and they smile in an affable style
Which is seldom accorded to Me.

Potiphar Gubbins, E.E.,
Mixed up his D. and A.C.
The fuses all spluttered and Potiphar muttered
Something beginning with D.

Careless and lazy is he,
Greatly inferior to Me.
What is the spell that you manage so well
Commonplace Potiphar G.?

Lovely Mehitabel Lee,
Let me inquire of thee,
Should I have riz to what Potiphar is
Hadst thou been mated to Me?

Veritas Vincit.

The Dignity of the Profession.

I am very glad to notice that at last we have a man who is prepared to sacrifice his position rather than put up with the insult paid to the electrical profession of appointing a "jointer" as assistant engineer. Why did not the Electrical Light Committee of the Elland U.D.C. go one farther on the score of economy, and elect a greaser or pupil to the position?

It would be rather interesting to see the financial results of their economy (*sic*) at the end of a year.

Surely an electrical engineer should know the best man to elect, seeing that it is to his own interest to run the station economically? What do the members of the average committee know about this?

May we have more men like Mr. Heron, is the wish of

Dignity.

Is Steel Conduit Wiring Doomed?

During the last few years steel conduit wiring systems have been used very extensively for indoor wiring, and for lighting more than anything else, and whenever new buildings are to be wired, it seems to be taken for granted that the conduit system must be used.

When the conduit system was first introduced it became popular almost immediately, and it was just as quickly classed the ideal system. Wiring in steel conduit was specified for here, there and everywhere. This was before experience had taught us the many ills and defects the tubes were liable to, and when the advantages *only* of the system were looked at.

Some engineers, and contractors especially, are beginning to find conduit installations a source of worry, trouble and expense.

During erection it is very nice to be able to bury the wiring in the plaster, on walls, and in ceilings, and to lay it in concrete floors, as the tubes and wires are then out of sight, and generally out of mind, until the light fails in some part of the buildings; then, after an examination, it is found that all fuses, lamps, &c., are *good*, and it begins to dawn upon the mind that it is a conduit job, and that nowhere can the wires be examined, although, after testing, it is proved there are broken ones somewhere. Then it is that the tube system begins to lose some of its former charm. Is not it a well known fact that in the bulk of installations, the largest number of wires possible, have to go into the least number of tubes, and when the first breakdown occurs, it becomes necessary to re-wire on the surface. Whenever steel conduit systems are used (light gauge), and buried in wet concrete, plaster, &c., trouble will follow sooner or later, as moisture will get into tubes, and tubes will rust, and vulcanised cables will not resist everything.

As I am very interested in wiring systems, I should like to know the experiences of some of your readers in regard to failures in conduit systems, and also an expression of opinion on: "Is steel conduit wiring doomed?"

For my part, I think it is, unless the nature of the conduit itself is improved so as to withstand the attacks of moisture, &c., or unless conduit systems are installed in a very different manner from that on which the bulk of installations are erected at present.

Hoping the matter will have fair discussion, and trusting I have not occupied too much of your valuable space.

H. Moss.

Birmingham, *December 27th*, 1904.

["CURIOSITY," who has omitted his name and address, is apparently unaware that demand indicators are usually given a time lag, so that an excess current taken for five or ten minutes only is not recorded.—EDS. E.R.]

THE CONTINENTAL ELECTRICAL ENGINEERING INDUSTRY.

GERMAN COMPANIES AND IMPROVED FINANCIAL RESULTS.

THE improvement noticeable in the German electrical industry during the past few months still continues, and from the reports which have been issued for the financial year ended June 30th, it would seem that several of the companies have begun to exhibit more satisfactory results. An abundance of work has been forthcoming in nearly all departments, and particularly in the production of dynamos, transformers, and batteries. No doubt the strong combinations which have been established in the past year or two have contributed towards the general improvement, which is expected to continue in the future. The question of forming a syndicate of cable-makers is under the consideration of the principal companies, although a decision has not yet been concluded. The Siemens-Schuckert Works Co. has just constituted two companies for the promotion of the business of the parent company, and also that of the Siemens & Halske Co., in Mexico and Brazil respectively.

The manufacture of the new Edison accumulator is about to be undertaken in Germany by a company to be formed for the purpose. Various rumours on the subject have been in circulation. It was at first reported that the company was to be established under the auspices of the Deutsche Bank and the Deutsche Credit Anstalt, and that the inventor was to become one of the directors, but this report has not been confirmed down to the present time. What, however, seems certain is that Herr Sigmund Bergmann, of the Bergmann Electricity Works Co., is the principal promoter of the new company, which expects to begin the manufacture of the battery in the works of the Garvin Maschinen Fabrik early next year. In the meantime the Cologne Accumulator Works Co., of Kalk, which owns the Waldemar Jungner battery patents, claims that the Edison accumulator falls within the scope of the latter invention.

GERMAN WORKS.

The accounts of the Allgemeine Elektricitäts Gesellschaft for 1903-4, show an improvement over those of the preceding financial year, and the more satisfactory position of affairs is emphasised by the larger amount of capital which shares in the profits. Having increased the share capital mainly for the purpose of absorbing the Union Electricity Co., the capital of the A.E.G. now stands at £4,296,600, as against £3,000,000 on June 30th, 1903, and of the former total the sum of £4,125,000 participates in the dividend for the past year, which is at the rate of 9 per cent., as compared with 8 per cent. in each of the two preceding years, 12 per cent. in 1900-1, and 15 per cent. in 1899-1900 on a capital of £3,000,000. After deducting £60,000 for interest on loans, the balance-sheet for the past year indicates gross profits amounting to £521,935, as against £349,200 in 1902-3, and net profits of £428,331, as compared with £281,219 a year ago. The payment of the dividend requires £371,250, the sum of £27.812 has been voted as fees and allowances, and £17,500 to the benevolent funds, while the balance has been carried forward. Early in November, when the dividend announcement was made, the directors intimated that the orders on hand represented £6,150,000, as against £4,350,000 at the corresponding period of 1903. The report now states that the number of employés, which was 18,278 in October, 1903, had been increased to 27,487 in the equivalent month of this year, and a further augmentation will shortly be necessary. During the year the sudden increase in the number of orders rendered it essential for almost all the machine tools in the shops to be kept constantly in operation day and night, and this state of affairs compelled the company to make additions to the machinery and extend the shops. In the turbine department, where the workmen have been increased to 1,200 men, orders have been abundantly received for turbo-dynamos of from quite small sizes up to plant of 6,000 H.P., and two ship engines of a combined output of 6,000 H.P., are so far advanced that they are expected to be erected on board in the spring. The Nernst lamp has been further developed, and owing to the growing demand the manufacture is to be transferred to a new factory which has yet to be built. After referring to the glow lamp syndicate, the company's cable factory and automobile department, the report remarks that the coal and iron industry is in general changing over to large power transmission plants, and that the employment of large electric motors has begun. Main shafts and rolling mill machinery, of which only a few are electrically worked at present, will afford an opportunity for the sale of motors of thousands of horse-power. These secondary plants will require primary dynamos in units whose size will be determined by the development of gas engines and steam turbines, and which in the latter case is already put at 10,000 H.P. The orders on hand for electric tramways exceed those in the previous year, and this is perhaps connected with the absorption of the Union Co. As to the agreement with the General Electric Co., of New York and its European subsidiary companies, the report states that the company participated in the A.E.G. Thomson-Houston Co., of Milan, to the extent of a nominal capital of £120,000, and transferred to its friends a share in its branch companies in France and England, namely, £8,550 in the Société Francaise d'Electricité, A.E.G. of Paris, and £29,840 in the Electrical Co., Ltd., of London. The English patents for the Nernst lamp have been transferred to the A.E.G. English Manufacturing Co. with a share capital of £150,000, which is held by the Berlin parent company. Among the displacements in the company's investments may be mentioned the realisation of a further batch (£200,000) of shares held in the Zurich Bank for Electrical Enterprises, and the acquisition of shares in the Brown-Boveri Co. The patent account is again entered at £40,000. The debts outstanding amount to £2,600,000, whereas the creditors represent £1,200,000, of which £1,000,000 relates to the Union Co., but this will practically be transferred to the A.E.G. on the termination of the liquidation of the Union Co. The credit at the company's bankers has risen from £980,000 a year ago to £1,345,000 at the end of the financial year.

The shareholders in the Union Electricity Co., of Berlin, have just approved the report and accounts for the year 1903-4. The report only dealt with the transfer to the Allgemeine Co., of the

company's working accounts, manufactures, patents, &c., and showed net profits amounting to £77,810. It was decided to devote £72,000 of this total to the payment of a dividend at the rate of 6 per cent., which had been guaranteed by the Allgemeine Co., to allocate £1,920 as fees to the board of supervision, and to place the balance to the reserve fund. The liquidation balance-sheet, which was also presented at the recent meeting, disclosed the fact that the only property remaining in the possession of the company is the land and buildings in the Hutten Strasse, which are at present leased to the Allgemeine Co.

The directors of the Siemens & Halske Co. propose to pay a dividend at the rate of 7 per cent. for 1903-4 as compared with 5 per cent. in the previous year.

The shareholders of the Berliner Telephone Works Co., of Hanover, have sanctioned an increase in the share capital from £50,000 to £150,000 for the purpose of liquidating bank and other advances obtained during the past financial year. A reference to the company's report for 1903-4 explains that these loans were rendered necessary owing to the extension of the business, and the larger credits thereby required. The turnover increased by 20 per cent. over that of the previous year, and the demand for better qualities of manufactures was greater. Including the balance brought forward from 1902-3, the accounts show a net surplus of £14,237 as compared with £8,150 a year ago, and a dividend has been declared at the rate of 9 per cent. on the capital of £50,000, as against 6 per cent. in 1902-3. The directors state that all the company's branches were favourably worked during the year.

The report for 1903-4 of the Electric Light and Power Investment Co., of Berlin, shows that the company has now acquired practically the whole of the ordinary and preference shares in the Cologne Company for Electrical Investments. In connection with this acquisition, and also for the purpose of increasing its funds, the Berlin company has made a fresh issue of bonds which now total £875,000, in addition to the ordinary share capital of £937,500. The net profits amount to £61,016, as compared with £59,460 in 1902-3, and it is proposed to pay a dividend at the rate of 5 per cent., being the same rate as in 1902-3, and comparing with 3 per cent. in 1901-2. The company is interested in different lighting and traction undertakings in various parts of the world, including the Underground Electric Railways Co. of London, while an advance of £60,000 is said to have been made to a London company during the past year.

The gross profits realised by the Schuckert Electricity Co., of Nuremberg, from investments, enterprises and securities amount to £174,658, as compared with £214,341 in 1902-3. After deducting general expenses, taxes and interest charges, and providing for depreciation, the net profits reach a total of £63,373 as against £6,677 a year ago. Having placed 5 per cent. of the surplus to the legal reserve fund, the directors propose, instead of recommending the payment of a dividend, to carry forward the balance of £60,205.

French and other Companies.

The report for 1903-4 of the Société Industrielle des Téléphones, of Paris, which has a share capital of £720,000, states that the net profits amount to £73,760, as compared with £52,020 in the preceding year. Of the former total, the sum of £39,600 has been distributed by the payment of a dividend at the rate of 13s. 3d. per share, as against 9s. 7d. per share in 1902-3. It is stated that the increase in the profits is due to the commencement of the manufacture of the Brest-Dakar cable, in connection with which a payment of about £160,000 has already been made on account by the French Government.

The Société d'Applications Industrielles (Compagnie d'Enterprises Electriques), of Paris, which was established in 1896, and has a paid-up capital of £200,000, is issuing a loan of £120,000 in 4½ per cent. bonds for the purpose of consolidating the floating debt. The company's report for the year ended June 30th, 1904, shows profits amounting to £11,283, of which the sum of £9,000 has been distributed in the form of a dividend at the rate of 4½ per cent. In the preceding year the profits were placed to a suspension fund, as a consequence of legal proceedings pending between the company and the City of Paris. The company's agreement with the Alioth Electricity Co., of Arlesheim, near Basle, has undergone certain modifications during the year.

The net profits of the Société Industrielle d'Energie Electrique (Schuckert company) for 1903 total £19,362, as compared with £32,584 in the previous year, when the payment of a dividend was not proposed. Notwithstanding the smaller profits earned in 1903, a dividend has been declared which is equivalent to 2·4 per cent. on a share capital of £400,000. The determination to pay a dividend, which was not approved without opposition on the part of shareholders, seems to have been forced upon the latter.

The Société d'Electricité Lahmeyer has been formed at Lille by the Lahmeyer Electricity Co., of Frankfort-on-Main. The object of the company, which has a share capital of £40,000, is to take over the French business of the German company, which has hitherto been carried on by the Brussels branch, which was established in 1902. It appears that the trade in France has recently increased so as to render it necessary to have a separate company, and the decision to constitute the latter has, perhaps, been accelerated by the success obtained by the German company at the exhibition which was closed at Arras at the end of October, and at which the company disposed of its exhibit of electric winding plant to the owners of the Ligny-les-Aire coal mines. It is stated that French manufacturers are included among the founders of the Lille company.

The Oerlikon Machine Works Co., notwithstanding the prevalence of greater activity during 1903-4, is unable to make any distribution on the ordinary share capital of £320,000, this being the second occasion upon which the dividend has been passed. The directors' report states that the sales of high-tension transformers and switches increased, that the experiments with electric traction are being continued, and that the initial difficulties in the turbine department appear to have been overcome. Although showing gross profits exceeding £52,000, the net profits become reduced to a mere trifle owing to losses on the branch businesses, and on the Russian-Swiss Oerlikon Co., and also in consequence of the necessity of writing down the value of investments, materials and presses, of which the company unfortunately undertook the construction a few years ago.

The Russian Union Electricity Co., of St. Petersburg and Riga, which is a manufacturing and installation concern, and also works several lighting stations, continued on the down grade during 1903. As against a revenue of £47,461 have to be set expenses totalling £107,283, thus showing a loss of £59,822, and including the deficit brought forward from the previous year, the total deficiency has been increased to £287,400. This adverse balance has been incurred on a share capital of £600,000, and an issue of obligations amounting to £250,000, the latter of which are in the possession of a bank syndicate as security. The company's factory at Riga has now been sold to the Russian Allgemeine Co., and this is doubtless due to the absorption by the Berlin Allgemeine Co. of the undertaking of the Berlin Union Co.

REPORT ON LIQUID FUEL.

In the newly-issued report of the U.S. Naval Liquid Fuel Board, an interesting calculation is made of the power necessary to atomise oil fuel. Petroleum, having a specific gravity of 0·92, has a bulk of 30 cb. in. to the lb. The surface of 1 lb. of oil when broken up into spherical drops has an area of $180 \div d$ where d is the diameter of the drops in inches. To stretch a petroleum surface demands 0·0000151 ft.-lb. per sq. in., whence the work done against surface tension when atomising is $0{\cdot}00272 \div d$ = ft.-lb. per lb. of oil. Assuming atomising to be carried to the extent of drops of 0·0001 in., the ft.-lb. of work would be only 27·2 per lb. of oil. The kinetic energy to throw the oil is calculated at 248 ft.-lb. per lb., so that the total energy is 276 ft.-lb.

It requires ½ lb. of steam to atomise 1 lb. of oil, and this would produce 28,700 ft.-lb. of work in a fair engine, and should spray 104 lb. of oil into drops of 0·0001 in. diameter. Hence spraying by steam jet has an efficiency under 1 per cent. It is, therefore, concluded that a simple mechanical burner that will supply atomised oil ought to be possible.

To this end, the oil should be supplied at a considerable pressure—at least 40 lb. per sq. in., and plants are said to be running with oil supplied at 150 lb. pressure.

Contrary to frequent claims, the air pressure to spray such oil need not be great. It would appear that atomisation is fairly well effected by the pressure of supply of the oil itself, and that the air merely carries off the spray as a cloud.

Very much cannot be said in favour of the general design and arrangement of the Hohenstein boiler with which the U.S. oil-fuel tests were conducted. There seems to us to be too little space for the complete combustion of oil between the nozzle of the oil sprayer and the first contact with the tubes of the boiler. It is not a matter of surprise, therefore, that some of the tests showed considerable smoke production.

The report states that furnishers of burners or atomisers, or particular systems of oil burning, very commonly advanced the erroneous claim that the steam used for atomising the fuel was itself burned. Whatever possible chemical advantage may accrue from the presence of steam, there can, of course, be no heat produced by burning dissociated hydrogen and oxygen that was not absorbed in the process of dissociation. There is also a general tendency to employ too few burners, the belief being too prevalent that the average oil-fuel burner can develop 500 to 600 H.P. This apparently is too high an amount of heat to be conveniently generated at one centre, and it is urged that more burners should be fitted. It seemed impossible to convince many otherwise well-informed experts that the capacity of every practicable oil-fuel burner was limited.

In admitting air for combustion the openings should be below the furnace, and about 1 sq. in. of opening is requisite with ordinary draught for each 16 lbs. of evaporation. This is rather an odd way of stating what is really only directly connected with the weight of fuel burned. Where possible the air should be heated. As regards heating of the oil, it is further stated that with a gravity of 15 to 18° Baumé, this should be heated to 120° F, while for oil of 20 to 30° the temperature should be 100° F. Above 30° gravity no heating is necessary beyond that done in the burner.

With forced draught an evaporation as high as 667 lb. of water per sq. ft. of what would be grate surface was obtained.

The bulk of the report is made up of detailed figures of tests.

Burners for oil were tried, which consisted of disks revolving at a high velocity, and throwing off the oil fed to them. These centrifugal burners seemed to be capable of good atomising results, and were not altogether unsatisfactory viewed as experiments. As such a burner must deliver spray all round the circle, it must stand in the centre of a furnace, and must be kept cool by the oil itself, and the air fed in with it, so that such burners require careful attention.

The report further states that there is a general popular feeling in favour of oil fuel; the report calls it a prejudice, for very little is said of the disadvantages of oil, and very much of its advantages. As regards even marine work, no very special advantage seems to have accrued, except in the Pacific, and in certain parts of the East Indies.

E

In Pacific steamships the economy of oil is obvious, for, pound for pound, oil costs less than any coal fit to put on board ship. The relative oil consumption as compared with an inferior grade of coal was 1 : 1·55 in the ss. *Alameda*. In the *Nebraskan*, 457 tons of space for cargo was saved by means of oil fuel, and the financial gain to the owners from all causes was £100 a day. The oil was Californian. Oil slightly refined—presumably, by driving off some of the lighter constituents which contain most sulphur—was, says M. Lassoe, less harmful than coal, where the oil was properly employed.

The Howden system of forced draught proved a decided advantage, and the smoke-stack temperature was at times as low as 375° F. The air pressure for atomising was only from 1·2 to 1·5 lb. per sq. in. Four barrels of oil would carry the ship as far as a ton of coal. A barrel is 33 to 35 imperial gallons.

With liquid fuel, the stokehold staff should be smaller, and of higher quality. There should be trained furnace-men rather than stokers, and the coal trimmer disappears.

The oil in the *Nebraskan* was heated to 175° F. at the burners, and was at a pressure of 15 lb. per sq. in. The atomising energy was thus, to some extent, in the oil rather than in the low pressure air supply. A very fine spray resulted. The atomiser had a central needle-controlled orifice for oil, and a set of 16 holes of $\frac{1}{4}$ in. diameter, directing air in a whirling direction. The boilers are of Scotch type, with $\begin{cases} 3' \ 7'' \\ 3' \ 3'' \end{cases}$ diameter Morison furnaces, lined to the back of the combustion chamber, along the bottom, and lined half the length of the crown. Thus the furnace is a clear space in which two burners are at work. The whole of the air supply is heated in the uptake and forced by a fan.

In the locomotive working the Hoosac Tunnel, the fire-box is brick-lined, and arched in lower half; two flat burners are employed, each with two openings 2 in. and $2\frac{3}{4}$ in. wide respectively. Steam atomisation is employed, and each burner will deal efficiently with 150 gallons of oil per hour. An excellent chapter on the mechanics of combustion is inserted. It deals with the necessities of perfect combustion, length of flame, intimate air mixture and temperature. Space and time are essentials. An interesting discussion is presented on types of burners. These are gathered under five heads or classes, and considered in their various modifications. It is also pointed out that systems involving the gasification of liquid fuel have not been successful.

Water separation is described, and it is pointed out that a thread of water carried into the oil burner effectually extinguishes the flame, which may not readily re-ignite if more oil do not speedily follow. Hence the advantage of more than one burner per furnace. No device for keeping out water appears better than the English float take off, with local steam heat to enable the water better to separate out of the thinned and lightened oil, which being rendered more fluid, can be more easily pumped through the pipes.

Every effort was made to give publicity to the trials, and anyone interested could observe the tests. It was recognised that facts must get out in time, and credit is due to the Navy department for taking care that such facts should get out correctly.

Finally, the admission and regulation of air is discussed. There being no grate resistance, the gases must be baffled between the furnace and the chimney and compelled to pass over the full extent of the heating surface. Air must be admitted from below the oil spray, or explosive effects may follow.

For the conditions of the English climate, it may be pointed out that less oil could be burned when the atmosphere was more humid. Humidity means so much less oxygen per unit volume, and it causes reduced diffusion effects. But further tests are considered necessary to show these effects more fully. The attendance on oil fuel installations must be of a superior order, and tinsmith work must be avoided. Everything should be of the best. The necessary precautions of drip pans, safety lights, &c., are pointed out. Less than 3 per cent. of the world's fuel consumption must, under present conditions of supply, be of oil.

THE TENDENCY OF PRACTICE IN POWER STATION ENGINE AND BOILER PLANT.

By FRANCIS H. DAVIES.

THE enormous developments that have taken place in electric light and power supply during the last few years, may be greatly attributed to the successful efforts that mechanical engineers have made to furnish their electrical brethren with suitable prime movers and means of generating power. In view of this fact, it may be of interest to follow the lines along which development of steam and other plant for electricity supply has proceeded in this country, particularly noting the difference that has existed in horse power installed between the leading types of boilers and engines at various periods during the last few years.

An attempt to show this graphically has been made in the following curves, which are based principally upon the information given in the ELECTRICAL REVIEW annual Electricity Works sheets. The completeness of the data afforded, especially in later years, has rendered possible a fairly accurate determination of the figures it was desired to get at, with comparatively little labour, and although these figures are not vouched for as absolutely correct, they are near enough to give a true indication of the proportionate popularity of the principal types of steam generators and prime movers.

The curves make patent facts which engineers are already broadly aware of, and their claim to interest can only be based upon the comparison that they afford of definite values over a period that has been an eventful one in the history of electricity supply work. Fig. 1 shows the horse-power in-

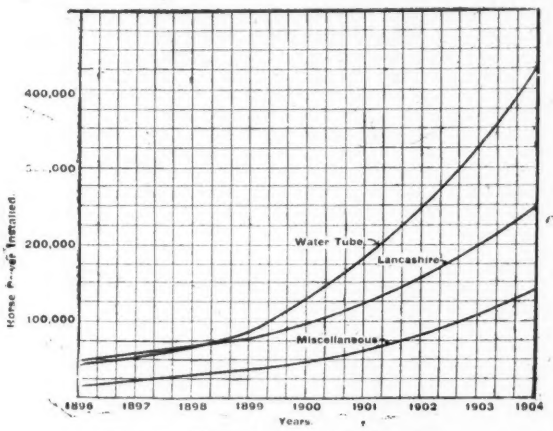


FIG. 1.—BOILERS IN POWER STATIONS.

stalled of various types of boilers at different periods extending from 1896 to the present date, or rather that at which the last table was published (June, 1904).

It is common knowledge that the water-tube and Lancashire types are practically supreme in electrical work, hence all other varieties have been embodied in one curve under the heading of "Miscellaneous." The feature of interest in this figure is not so much the very large general advance that it shows, as the marked increase in popularity of the water-tube boiler, evidenced by a rapid ascent of its curve in a manner out of all proportion to the increase in other types.

Starting slightly under the Lancashire boiler in 1896, and probably lower still in preceding years, it has now passed it

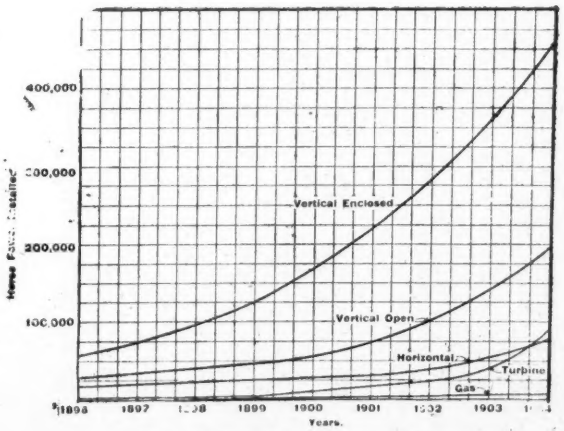


FIG. 2.—ENGINES IN POWER STATIONS.

by nearly 75 per cent., and this despite a very fair increase in the horse-power of its rival. The "Miscellaneous" curve shows a smaller rise, and, indeed, it is only the marine boiler that keeps it from assuming a flat or drooping characteristic.

To what extent the relative proportions of these three curves will vary in another eight years it is difficult to say; but judging from their direction, it appears probable that as

long as the steam engine holds the premier place as a prime mover, the water-tube boiler will be the favourite by a very large margin.

The Lancashire boiler must always have its sphere of usefulness in electrical work, and will doubtless increase steadily in horse-power installed to much the same extent as it has done in the past, but any increase comparable with the meteoric ascent of the water-tube boiler is, of course, not to be expected.

Fig. 2 is of greater interest, as it deals with all kinds of prime movers, although perhaps somewhat inadequately owing to the difficulty of showing proportionately on one sheet such widely different values as it contains.

Here, again, the recent wide divergence between the curves of various types is the point of greatest interest. Anyone with only a superficial knowledge of present-day practice would expect the high-speed enclosed engine to stand first, but perhaps scarcely to the extent that it does. The reason is, of course, the immense number of small installations that exist, combined with the suitability of this type of engine for such work.

The increase in electric tramways accounts greatly for the substantial rise of the vertical open type, and partly for that of the horizontal, but the latter is evidently not generally favoured, and its curve evinces a greater disposition to go flat than that of any other steam engine.

The turbine curve constitutes the most interesting one of the figure. Starting almost at zero only a few years back, it has passed the horizontal engine in horse-power installed, and shows an upward tendency that looks like business. Its suitability for large power work is the cause of the recent rapid ascent of its curve, and as railway and bulk supply schemes take tangible shape, it will undoubtedly go much higher, and will certainly pass the vertical open type in another year or two.

Evidently, it is between this and the vertical enclosed engine that the battle of the future for steam supremacy will take place; and there are not wanting signs, evidenced by the "Correspondence" columns of the Electrical Review some months back, that this will be a struggle of a formidable nature. It would appear that for some time at least there will be ample room for both, but while the vertical engine is comparatively old and has been brought to practically the highest stage of perfection it is possible to reach, the turbine, while still young, is a formidable competitor, although it cannot be said to have in any way reached finality.

Meanwhile, the gas engine as shown by the bottom curve is making progress; not much, certainly, but another year will probably show a marked increase. Despite the excellent fuel results shown in many towns where it has been adopted, it has not yet thoroughly gained the confidence of engineers, who are naturally somewhat chary of risking their reputations even in the slightest degree. The general opinion, and probably the correct one, is, however, that it has a great future before it, and many, though hesitating at the present to recommend its use for the above reason, at the same time hold the idea that it is destined eventually to usurp practically the entire field of electricity supply.

A look into the future, guided by the indication of these curves and the general tendency of engineering opinion, would appear to reveal the following:—

The horizontal engine will probably disappear, or at any rate, become negligible in comparative quantity.

The vertical open engine will survive it by many years, not from any inherently superior points, but by a very natural conservatism on the part of steam users, and affection for an old and well-tried servant.

The vertical enclosed engine and the turbine are the steam engines of the future; to what proportionate extent cannot yet be conjectured, but doubtless another three or four years will show.

In the meantime it is significant that many leading firms, although not discontinuing to build the reciprocating type, have recently taken up the manufacture of turbines.

The gas engine is a dark horse, and with it in this respect may be classed the modern type of oil engine. Both show an economy in many ways superior to that of the best steam engine, but, as stated, they have not yet gained full confidence. Evolution must do its work here, and, as usual in such cases, its dependence upon conditions that may at any moment vary very considerably, makes any sort of prophecy or deduction liable to fall very wide of the mark.

ELECTRIC TRAMWAY LEGISLATION IN THE COLONIES AND INDIA.

[From our Legal Contributor.]

Some weeks ago a lengthy article was published in the Electrical Review, setting forth the material provisions of Colonial Acts and ordinances relating to the supply of electricity for light and power. It was stated in the early part of that article that the field for development of electrical enterprise in the British Islands was rapidly becoming smaller, and an attempt was made to show what fields were open for further exertion in those portions of the King's dominions beyond the seas. Similar observations apply and with equal force to electric tramway enterprise.

It is therefore proposed to give a short summary of the law as it is now in force.

One or two observations of a general nature must be made with reference to Colonial tramway legislation. In many of the Colonies there are no Acts at all, while in others the only measures now in force are similar to what we know as private Acts in this country. In other places, as, for instance, in South Australia, while the construction of a tramway may be authorised by a public Act, the right to work it by electricity is conferred by private Act.

In accordance with the above objects, the following states and dependencies will be found to have been dealt with (in alphabetical order):—I., Australia, including (*a*) New South Wales; (*b*) Queensland; (*c*) South Australia; (*d*) Victoria; and (*e*) Western Australia; II., British Columbia; III., British Guiana; IV., Canada, including (*a*) New Brunswick, (*b*) Ontario, (*c*) Quebec; V., Cape Colony; VI., Ceylon; VII., India; VIII., Jamaica; IX., Natal; X., New Zealand; XI., Southern Rhodesia; XII., Tasmania; XIII., Transvaal; XIV., Trinidad and Tobago.

With reference to colonies and dependencies of the Empire which are not included in the above list, the reader should not infer that the reason for their omission is the absence from their respective statute books of tramway legislation.

I.—Australia.

(*a*) *New South Wales.*—In 1896 an Act was passed intituled the Electric Traction Act, 1896 (60 Vict., No. 22). This Act provides that "it shall be lawful for the Commissioners to use either in addition to, or in substitution for, any existing system of traction on tramways any system of electric traction of which they may approve, and to construct, maintain and repair and use all works necessary for such system of electric traction" (Sec. 2). Where a private company or person seeks to establish and construct an electric tramway, it is necessary to obtain power to do so by special Act. See, for instance, the Capertee Tramway Act, 1899.

(*b*) *Queensland*, 46 Vict., No. 10, 1882.—In Sec. 5, Sub-sec. 1, this Act states that, subject to the provisions of this Act:—

(*a*) A company of persons registered under the Companies' Act, 1863, or

(*b*) The council of a municipality, or any other local authority, having control for the time being of any part of the streets in which a tramway is laid or intended to be laid—may construct, maintain and work a tramway upon and through any street or other place, with all proper rails, plates, works, sidings, junctions, stations, approaches, and conveniences connected therewith; and may enter upon, purchase, take and use any land required for these purposes. Sub-sec. 2 provides that "every such company, Council, or other local authority as aforesaid, shall be deemed to be the constructing authority for the purposes of this Act."

Sec. 6, Sub-sec. 1, lays down that "When a constructing authority desire to undertake the construction of a tramway, they shall apply to the Minister for an Order in Council to

construct the same, and shall cause to be prepared (*a*) plans, sections, specifications and book of reference of the proposed tramway; and (*b*) an estimate of the cost of same."

Sub-sec. 2 adds that "A certified copy of such plans, sections, specifications, book of reference and estimate shall be deposited with the Minister, and in the office of every Council or other local authority having jurisdiction over the streets in which the tramway is proposed to be laid."

When the constructing authority is a company, it is provided by Sub-sec. 3 that "they shall also deposit with such plans—(*c*) a certified copy of the memorandum and articles of association; (*d*) a statement showing the name and place of residence of every shareholder, and the number of shares held by him; (*e*) and a statement of the amount of capital paid up to date." It is further provided by Sub-sec. 4, that "The company shall also deposit in the Colonial Treasury a sum equal to $\frac{1}{20}$ part of the estimated cost of the tramway, which sum shall be detained by the Treasurer as security for the due completion of the same."

Publishing of notices is dealt with in Sub-sec. 5, which orders that "A notice stating that such application with plans, sections, specifications, books of reference, and other documents (if any) have been deposited as aforesaid, and are at all reasonable times open to the inspection of every ratepayer interested therein, shall, at the cost of the constructing authority, be published for one month at least; (*f*) in some newspaper generally circulating in the district through which the tramway is to be laid; (*g*) in the *Gazette*; and (*h*) in one of the Brisbane daily newspapers."

Sub-sec. 6 orders that "A true copy of every newspaper containing such notice, and a reference to the dates and pages of the *Gazette* containing the same, shall be deposited with the Minister before he submits an application to the Governor in Council."

Petitioning against the tramway is dealt with in Sec. 7, Sub-sec. 1. "Within one month after the first publication of the notice aforesaid, any corporation or person having property likely to be affected or injured by the proposed tramway, may forward through the Minister a petition to the Governor in Council, praying that the application may be refused or the plan altered, as the case may be, for the reasons set forth in the petition." Sub-sec. 2 adds that "Every signature to a petition other than the common seal of a municipality shall be verified by the solemn declaration of some person signing such petition, and no petition unaccompanied by such declaration shall be received by the Minister."

Sec. 8., Sub-sec. 1, lays down that, "At the expiration of two months after the notice of an application has been advertised in the *Gazette*, the Minister, if satisfied—(*a*) that the provisions of this Act have been substantially complied with; (*b*) that the Councils having control over the streets through which the tramway is proposed to be laid, have made no reasonable objection to its construction; (*c*) that the construction and working of the tramway will be for the public benefit; and (*d*) that the capital of the company (if a company be the applicants) as fixed by the memorandum of association, is sufficient for the proper construction, equipment, and working of the tramway, shall submit the application to the Governor in Council, with all petitions and other documents relating thereto, together with the Minister's recommendation in respect of such application." Then Sub-sec. 2 provides: "The Governor in Council may thereupon make an order in Council (*a*) approving of the plans and authorising the applicants, subject to the provisions of this Act, to construct the tramway within such time, and with such modifications, if any, as appear to him expedient; or (*b*) disapproving of the plans, and refusing the applicants permission to construct the tramway." Then Sub-sec. 3 adds that "The applicants, when so authorised, may take, under and subject to the provisions of the Public Works Lands Resumption Act, of 1878 (42 Vict., No. 5) any lands required for the purposes of this Act."

Secs. 9—27, inclusive, deal with the power to borrow money for the purposes of constructing the tramways. Borrowing power of company is dealt with in Sec. 9. Then "Every mortgage made or issued under the authority of this Act shall be subject to the power of purchase reserved to the Council by this Act." (Sec. 10.)

Sec. 11 deals with the form of debenture, and orders that "Every mortgage-debenture issued by the company shall be in the form, or to the effect, of the first schedule to this Act (Sub-sec. 1); under the common seal of the company, and signed by two directors (Sub.-sec. 2); numbered consecutively so that no two debentures shall at any time bear the same number (Sub.-sec. 3); for a sum of not less than £100 (Sub.-sec. 4); and repayable both as to principal and interest, at a place within or without the colony named in the debenture, and at a time specified therein not exceeding 25 years from the date of issue thereof."

Sec. 12, Sub.-sec. 1, provides that "Interest shall not exceed 6 per cent. Separate coupons for such sum so payable in the form, or to the effect, of the second schedule hereto, and numbered consecutively for each debenture, shall be attached thereto (Sub.-sec. 2)." Under Sub-sec. 3 the company may not sell at a discount.

(*c*) *South Australia.*—In South Australia it appears that while tramways may be authorised under certain public Acts, the right to work them by electricity is only conferred by private Act.

The General Tramways Act, 1884 (47 and 48, Vict., No. 309) regulates the construction and working of all tramways. Sec. 3 provides that:—"This Act shall apply to every tramway undertaking to be authorised by any Act which shall hereafter be passed; and all the clauses and provisions of this Act, save so far as they shall be expressly varied or excepted by such Act, shall be incorporated therewith and apply, so far as applicable to the undertaking authorised thereby."

It is provided by Sec. 24 that "All carriages used on any tramway shall be moved by the power prescribed by the special Act, and when no such power is prescribed, by horses or mules only." Power to use electricity is given by private Act. Thus in the Adelaide and Suburban Tramways Electrical Traction Act, 1901 (1 Edward VII., Private Act) it is stated that "The clauses and provisions of the General Tramways Act, 1884 (save so far as they are hereinafter varied or excepted or are inconsistent with the provisions of this Act) shall be incorporated with this Act." (Sec. 2.) Full power to convert the present system of traction by horse-power on the various lines to electrical traction is given. (Sec. 6 *et seq.*)

(*d*) *Victoria.*—There does not appear to be any Act in the Colony of Victoria which deals with the use of electrical power for traction on tramways. It is conceived, however, that the Tramways Act, 1890, when read together with the Electric Light and Power Act, 1896, and the amendments of that Act passed in 1900 and 1901, ought to be sufficient to enable the undertakers of a tramway to use electricity. As to the provisions of the Electric Light and Power Acts, 1896, 1900 and 1901, they are set out shortly in the Electrical Review, September 30th, 1904.

(*e*) *Western Australia.*—The Tramways Act, 1885 (49 Vict., No. 23), is an Act to facilitate the construction and working of tramways. "Provisional orders authorising the construction of tramways in any district may be obtained by (1) The local authority of such district; or by (2) Any person, persons, corporation, or company, with the consent of the local authority of such district, and any such local authority, person, persons, corporation, or company shall be deemed to be promoters of a tramway, and are referred to in the Act as the promoters" (Sec. 3).

"All carriages used on any tramway shall be moved by the power prescribed by the special Act, and where no power is prescribed, by animal power only . . . " (Sec. 26). The special Acts, together with the provisional orders, passed subsequent to 49 Vict., No. 23, are numerous, and many of them prescribe electricity as the motive power which may be used on the tramways authorised by them.

II.—British Columbia.

In British Columbia the Tramway Company Incorporation Act (1895, C. 55) deals, *inter alia*, with the formation and incorporation of tramway companies. Any company incorporated under this Act has power to construct, maintain, complete, and operate a single or double track tramway (Sec. 7). The same section provides further on, that "any company incorporating under the Act shall have power to take transfer and carry passengers and ore, minerals and freight, upon their tramway by the force or power of animals, or such

steam, electric, water, or other motive power as the company may deem expedient." (Sec. 7.)

Certain clauses of the British Columbia Railway Act are, *mutatis mutandis*, to be incorporated with this Act, and are to apply to any company formed thereunder (1895, C. 55, Sec. 14). There are numerous private Acts of companies formed under the Act of 1895.

III.—British Guiana.

The construction of tramways in British Guiana is regulated by the Tramways Ordinance, 1899. This Ordinance facilitates the construction, and regulates the working of tramways. "The Governor in Council" may grant licenses authorising the construction of tramways (Sec. 3). Cars and carriages may be propelled by electricity or other motive power (Sec. 3).

The duties of the applicant for a license are prescribed in Sec. 4, where it is laid down that—"Any person desirous of obtaining a license under this Ordinance must address an application in writing to the Governor in Council in which he shall (*a*) give an address in Georgetown to which communications to him may be addressed; (*b*) specify the area for which the license is required; (*c*) specify the route or routes along which he proposes to lay a tramway; and (*d*) show the nature of the motive power or (in the alternative) powers which he proposes to adopt" (Sec. 4). "All carriages used on any tramway shall be moved by the power prescribed by the license, and where no such power is prescribed, by animal power only" (Sec. 29). It will thus be seen that it is necessary to obtain specific power to use electricity.

IV.—Canada.

(*a*) *New Brunswick.*—There does not appear to be any public tramway Act in force for New Brunswick, which would enable a private company or local authority to lay down and operate a tramway. It is necessary in this colony to obtain the passing of a special Act of Assembly in order to construct and work a tramway. As an illustration of such an Act, we may mention the Moniton Electric Tramway Co., 1890 (53 Vict., c. 74). As has already been pointed out,* there is no public Act in force in New Brunswick which regulates the supply of electricity. This colony, therefore, seems to be somewhat backward in matters electrical.

(*b*) *Ontario.*—The law relating to the construction and working of electric tramways in Ontario, Canada, may be found summed up in the Street Railways Act (R.S.O., 1887, c. 171 and in R.S.O., 1897, c. 208). "The Lieutenant-Governor in Council may, by letters patent under the Great Seal, grant a charter under the Ontario Companies' Act, incorporating a company for the purpose of constructing and working a street railway or lines of street railway in any local municipality, or in two or more adjoining local municipalities. (Act of 1887, Sec. 3)." Every such company shall, subject to any provisions contained in the charter, or in its bye-laws, have authority to construct, maintain, complete and operate . . . . and to take, carry and transport passengers upon the same by the force or power of animals, or by such other motive power as the company thinks proper, and as the municipal council authorises, and to construct and maintain all necessary works, buildings, appliances and conveniences connected therewith. (Sec. 11, Sub-sec. 1, R.S.O. 1897, c. 208.)

The company shall have power (*a*) to construct, maintain and operate works for the production of electricity for the motive power of the railway and for lighting and heating the rolling stock and other property of the company. (Sec. 14, Sub-sec. 1).

Electric railways are further dealt with in an Act respecting electric railways intituled the Electric Railway Act (R.S.O. 1897, c. 209). They are also dealt with in the Acts to amend the Street Railways Act (63 Vict., c. 31, 1900) and (1 Ed. VII., c. 25., 1901) and (2 Ed. VII., c. 26, 1902), also in an Act respecting electric railways (2 Ed. VII., c. 27, 1902). For a more detailed treatment of the various provisions of these Acts relating to the supply of electricity, see the Electrical Review, October 7th, 1904, p. 598.

(*c*) *Quebec.*—In order to obtain powers to construct and work tramways in Quebec, it is apparently necessary to obtain a special Act to incorporate the company. A recent instance of such an Act is the Act to incorporate the Suburban Tramway and Power Co. (4 Edward VII., c. 77, 1904). Under an Act of this kind power will be conferred to work a tramway by electricity.

* Electrical Review, October 7th, 1904, p. 598.

V.—Cape Colony.

The tramways of Cape Colony are constructed and worked by private companies, or syndicates, incorporated and given the necessary powers by the Governor of the Cape, with the advice and consent of the Legislative Council and the House of Assembly. Such an Act is the Southern Suburbs of Cape Town Tramway Act, 1896, No. 29, amended in 1897. There is usually a clause in these private incorporating Acts stating that the tramways shall not be exempt from any general Act that may subsequently be passed. These are nearly all electric tramways.

VI.—Ceylon.

The Act or ordinance to facilitate the construction and regulate the working of tramways in Ceylon is Ordinance No. 5 of 1873 (subject to Ordinance No. 7 of 1887, Sec. 160, as to power to make and improve streets). "The 'promoters' shall mean any person, corporation or company authorised by proclamation in the Government *Gazette*, to be issued by the Governor, with the advice of the Executive Council, for that purpose, to construct and work tramways in any part of this island, and any person, corporation or company claiming under the said promoters" (Ordinance No. 5, 1873, Sec. 2, Sub.-sec. 2).

Power to break up the roadways must be obtained from the local authorities (Sec. 3).

VII.—India.

The Indian Tramways Act, 1886 (Act No. 19 of 1886). This is an Act to facilitate the construction and to regulate the working of tramways.

"The Local Government may make an order authorising the construction of a tramway in a circle on application made—(*a*) by the local authority of the circle with the consent of the road authority of any road or part of road which is to be traversed by the tramway and of which the local authority is not itself the road authority; or (*b*) by any person with the consent of the local authority of the circle and of the road authority of any road . . . . . Provided that, if any part of the proposed tramway is to traverse land which is not included within the limits of a municipality or of a cantonment, the Local Government shall not make the order without the previous sanction of the Governor-General in Council (Sec. 4, Sub-sec. 1). The consent of the local or road authority is not necessary in certain cases" (Sec. 5). Procedure for making an order is dealt with in Sec. 6. "The order may also provide, in manner consistent with this Act, for all or any of the following, among other matters, that is to say:—(*m*) the motive power to be used on the tramway, and the conditions on which steam power or any other mechanical power may be used" (Sec. 7, Sub-sec. 2, *m*). "A tramway shall be constructed and maintained in the manner provided by the order" (Sec. 11). "In addition to any other power to make rules expressly or by implication conferred by this Act, the Local Government may make rules consistent with this Act—(*e*) for regulating the use of steam power or any other mechanical power on a tramway" (Sec. 24, Sub-sec. 1).

There is an Act, intituled the Indian Tramways Act, 1902 (Act No. 4, 1902), to apply the provisions of the Indian Railway Companies' Act, 1895 (Act No. 10, 1895), to certain tramway companies.

VIII.—Jamaica.

The first general Act for the constructing and working of tramways is Law No. 27, of 1895. The preservation of existing rights is dealt with in Sec. 2. The construction of tramways is licensed by the Governor in Privy Council (Sec. 3). To obtain a license it is necessary under (Sec. 4) for the applicant to address an application in writing to the Governor in Privy Council, in which he shall (*a*) give an address in Kingston to which communications to him may be addressed; (*b*) specify the area for which the license is required; (*c*) specify the route or routes along which he proposes to lay a tramway; and (*d*) show the nature

of the motive power, or (in the alternative) powers which he proposes to adopt. The applicant shall also deposit with the Clerk of the Privy Council, along with the application (1) a map of the area, indicating the limits thereof, on a scale of not less than 1 in. to the mile; (2) a proper and correct plan or map to a scale of not less than 4 in. to a mile with the line of the proposed tramway delineated thereon. . . . The present subsisting grades and curvatures of the streets and roads along the proposed routes may be adhered to; but if it is proposed to alter the same in construction, any such alterations shall also be shown by means of plans and profiles thereof to a scale of not less than 1 in. to a 1,000 ft.; (3) an estimate of the expense of the proposed works, with a statement of the capital which the applicants are prepared to raise for the purpose of carrying out the project; and (4) a draft of the license desired. All these documents must be typewritten or printed and delivered in triplicate. (Sec. 4.)

The applicant shall publish daily for two consecutive weeks, an advertisement in two newspapers published in Kingston (Sec. 6). The promoters must deposit a sum not exceeding £2,000 (Sec. 11). "All carriages used on any tramway shall be moved by the power prescribed by the license, and where no such power is prescribed by animal power only" (Sec. 29).

Law 22, of 1897, amends the Tramway Act, 1895 (Law 27, 1895), in the following sections: 12, 13, 15, 18, 19, 22, Sub.-sec. 1 of 23, 31, 33, and adds a few new sections.

Law 27 of 1895 is further amended by Law 1, 1899, as to temporary licenses for portions of tramways. "Law 1 of 1899 and Laws No. 27 of 1895 and No. 22 of 1897 shall be read together and construed as one law." (Law 1, 1899, Sec. 5.)

IX.—Natal.

Law 19 of 1880 confers upon the Durban Tramways Co., Ltd., the right and power to construct tramways in and along certain roads and work them by animal power. Law 18 of 1885 authorises and empowers the Suburban Tramways Co., Ltd., to construct tramways along certain roads, and to work such tramways with cars or carriages drawn by animal power, or driven by steam *or other motive power*. These are private Acts granting powers to private companies. These two Acts are amended by Law 16, 1892, as to the motive power, &c. "The carriages used on the tramways may be drawn by horses or other animals, or driven or propelled by steam or other motive power . . ." (Law 16, 1892, Secs. 1 and 2.)

There is also an Act (No. 20, 1902) amended by a further Act (No. 24, 1903) dealing with the authorisation of a company, for the construction and working of tramways by electricity.

X.—New Zealand.

The Tramways Act, 1894 (58 Vict., No. 57).—"An Act to amend and consolidate the law relating to tramways." This Act is divided into four parts—viz., Part I.—The construction of tramways, including provisions relating to the working of tramways by electricity. Part II.—Delegation of powers to construct and work tramways. Part III.—Assignment of delegated powers and of tramway. Part IV.—Provisions as to existing public tramways, &c. Part V.—Private tramways.

Part I.—*The Construction of Tramways.*—Tramways may be constructed in any borough town, district or country when authorised as provided in the Second Schedule to the Act, and all regulations in the schedule shall take effect as if they were the Act (Sec. (4), Sub-sec. (1)). (See schedule as epitomised *post*). Every tramway so constructed shall be subject to the provisions of Part VII. of the Public Works Act, 1882, relating to the inspection of railways, as if such tramway were a railway (Sec. 1 (2)).

The construction of tramways, authorised pursuant to the regulations in the Second Schedule of the Act, shall be deemed a public work within the meaning of the Public Works Act, 1882 (Sec. 6 (1)). Any local authority may purchase, or take under the provisions of the Public Works Act, 1882, any land necessary for the construction and maintenance of tramways within its district (Sec. 6 (2)).

Sec. 7 provides that: "Any order authorising the construction of a tramway, or any further order revoking, extending, or varying any order made, whether before or after the passing of the Act, may prescribe electricity as the motive power; provided that such order or further order shall also prescribe the system, whether overhead or otherwise, upon or according to which the electricity is to be applied and used.

By an Act passed in 1896 (60 Vict., No. 47) relating to electrical motive power, it is provided that: "It shall not be lawful for any local authority to grant to any person any right or concession for the purpose of either generating or using electricity as a motive power without in each instance the previous consent of the Governor by Order in Council gazetted." (Sec. 2.) Concessions made in breach of the Act are made void by Sec. 3. As to the using of waterways for the purpose of supplying electrical motive power (Sec. 4 (1)) lays down: "The Governor in Council may from time to time cause such inquiries to be made as he thinks fit in order to ascertain the feasibility of utilising the waterways of the Colony for the purpose of supplying electrical motive power for use on the goldfields." Reports as to result of inquiries are to be laid before Parliament (Sec. 4 (2)).

XI.—Southern Rhodesia.

There are no general Acts dealing with the question of constructing and working tramways in Southern Rhodesia.

The Act dealing with electricity, the Electric Lighting and Power Regulations, 1898, amended in 1903 by the Electric Lighting and Power Ordinance, 1903.

XII.—Tasmania.

The right to construct and work tramways in Tasmania is obtained by means of private Acts of Parliament. The Zorham Tramway Act, 1891, is an example of such a measure. It was there provided that plans must be submitted to the Minister before commencing or undertaking any of the tramways (Sec. 6). All carriages used on the tramway might be worked by steam, horse-power, cables, or by electricity, or such other motive power as the promoters might think suitable (Sec. 30). By Sec. 66, it was made lawful for the promoters, at any time after the passing of the Act, to assign, transfer, convey and release, to any company, duly incorporated for that purpose, all the rights, powers, authorities, privileges, liabilities, and obligations conferred and imposed upon them by the Act. After twenty-one years, upon giving six months' notice, the Minister might purchase the undertaking (Sec. 66). One other tramway Act is now in force in Tasmania, viz. ((1901), No. 6 Edw. VII.). That Act incorporates certain provisions (Secs. 5—33) of the Railways Construction Act, 1885.

XIII.—Transvaal.

Under Ordinance, No. 58 of 1903, "The Councils of Municipal Corporations may, with the consent of the Lieut.-Governor, construct, equip, and carry on within or beyond the municipality, tramways or works . . . . . " (Sec. 36). The Johannesburg municipal authorities obtained power to levy special rates for the construction and working of tramways under No. 62 of 1903.

There are certain conditions precedent to be observed before the Council can construct tramways (Sec. 3). The Volksraad, by the Volksraad Resolution, Art. 150—180, resolved as follows:—(1) "That no person whomsoever shall have the right to construct and exploit within the limits of this State, any rail or tramways propelled by other than animal power without having thereto obtained the express consent of the Volksraad, or the Executive Council, or the Government thereto authorised by the Volksraad."

XIV.—Trinidad and Tobago.

There is no general tramway Act in Trinidad. In 1882, however, Joseph Brown Payne obtained an ordinance (No. 8 of 1882) to enable him to lay down, work and maintain tramways in the borough of Port of Spain. The motive power authorised is "engines" (Sec. 9), which, it is presumed, would include the use of electrical power. The ordinance was amended in unimportant particulars in 1882, 1883 and 1895. In the Belmont Tramway Ordinance of 1892 (No. 21) powers to construct and work a tramway were conferred upon James Stanley Toppin. That ordinance provided that: "It shall be lawful

for the said James Stanley Toppin to use any motive power for the propulsion of the conveyances. . . . Provided always that he may, with the permission of the Governor, use any form or description of engine or carriage which would at the time when such carriage or engine is used, be permitted to be used on any public tramway in London, or in any town in England (Sec. 8).

A MULTIPLE-DIAL POTENTIOMETER.

By ALBERT CAMPBELL, B.A.

Some two years ago, in planning a low-resistance potentiometer which I was building for myself, I was led to consider what would be the best construction, from the point of view, first, of ease of mechanical construction, and secondly, of accuracy, convenience of reading, and compactness. There seems no doubt that circular motion is easier to

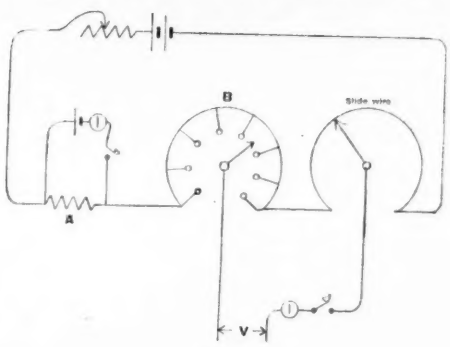


Fig. 1.

attain mechanically than rectilinear, and besides, a couple is applied with more ease than a single force, or, in ordinary language, a turning head is handier than a slider guided in a straight path. The latter requires much more movement of the hand and a steadier support for the instrument. Thus I decided on a thick slide wire, which could be bent into an arc of a circle, and a number of studs for the other contacts, the arrangement being as in fig. 1, where A is a fixed resistance, on which to balance a cadmium cell, and V is the voltage to be measured, the whole a tolerably

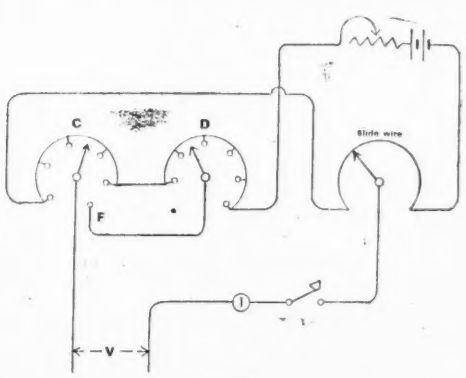


Fig. 2.

familiar construction. I wished, however, to have both convenience and accuracy, and accordingly decided to have 100 coils in the resistance at B. To have arranged these 100 coils all in one circle, meant considerable mechanical skill, and a great area of ebonite, but I found that both of these difficulties were got over by the device I proceed to describe; although very simple, I believe it is quite novel. Instead of arranging the 101 studs in one circle, I placed them in two sets as shown in fig. 2 at C and D, *but the last stud* F *on dial* C *was connected*, as shown, *to the turning-head of dial* D. Thus, when the slider of C has exhausted all its 50 coils, it arrives at F, and so switches the second slider into action on dial D. The switch-over stud F is marked blank, the other studs being numbered consecutively. Clearly the same principle can be applied to any number of dials, the only disadvantage of the method in its simplest form being that one must be careful always to read on the first dial that does not show a blank. This trouble may be avoided in various ways. When the sliders are fitted with number-disks showing one figure at a time, it is not difficult to arrange that the reading of the second dial shall be kept hidden by the rim of the first disk, except when the first slider is on the switch-over stud F. In the actual instrument that I built, I got rid of all uncertainty by adding an interlocking arrangement, so that the second slider remains locked at its zero position until the first slider is turned to stud F; then, on turning the second slider onwards, the first is locked on stud F and cannot be moved until the second is brought back to its zero position again. The simple mechanism by

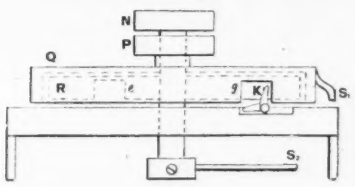


Fig. 3.

which this is accomplished is shown in fig. 3 (omitting irrelevant mechanical details). The two dials are fixed one over the other, and the sliders, S_1 S_2, are carried by concentric hollow spindles, whose heads N and P come close together in the hand. The spindles carry number-disks Q and R, the figures on the lower disk being visible through a hole in the upper one when this is in the proper position (on stud F); *e* and *g* are radial slots in the disks, and into these the double cam K works. Thus the only position in which both disks are free to move is when the two slots are together. In all other cases one of the two sliders is locked. The result is that in handling the double head one passes smoothly and continuously from the one slider to the other. For the simpler construction, in which the slider axles are not concentric, it is easy to modify the cam mechanism to suit. In conclusion, I may remark that the above device of multiple sliders can similarly be applied to a long slide wire sub-divided into a number of sections.

BUSINESS NOTES.

Colliery Electrical Plant.—The Alliance Electrical Co., Ltd., has just completed the installation of a colliery equipment for the Farrington Colliery Co., Ltd. The total output of the machinery installed aggregates to 255 B.H.P., and the work consists of power house, electrical haulage gears, electrically-driven pumps, and electric light on the surface and in the pit. All the machinery is on the direct-current system with 550 volts in the dynamo house. The Alliance Electrical Co., Ltd., have carried out a similar installation for the Norton Hill Collieries, the plant consisting in this case of electrically-driven pumps and the lighting of the collieries.

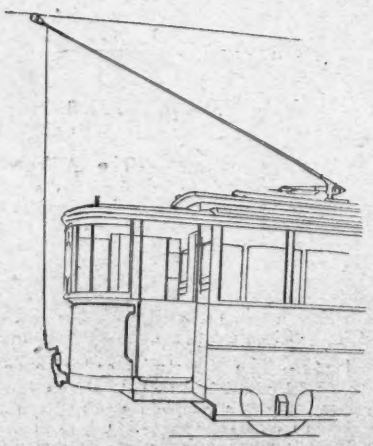
Lamp Tests.—The Westminster Electrical Testing Laboratory (The Electrical Testing Laboratories, Ltd.) announces that it is carrying out a complete series of tests on all the principal makes of incandescent lamps. Copies of the results will be sent to a limited number of subscribers by arrangement. Full particulars of the arrangements made will be sent on application to York Mansion, York Street, Westminster, S.W.

Electrical Education.—The Middlesex Education Electricity Class (Enfield Centre) which was recently started by the Middlesex County Council Local Committee, has 48 students, and its success made it necessary that the Committee should secure further assistance beyond the services of the instructor, Mr. Albert E. Short, A.M.I.E.E., who was teaching the elementary and advanced. The Committee consulted Dr. Silvanus P. Thompson, and availed themselves of his offer to permit his private assistant, Mr. A. R. Taylor, to co-operate with Mr. Short. On Saturday afternoon, December 17th, a very pleasant wind up to the first term was made by a visit to the Brimsdown supply station of the North Metropolitan Supply Co., by kind permission of Mr. G. Johnson, the secretary of the company. The party, which included the two instructors, Messrs. Short and Taylor, with Mr. Mullett, the class manager, was conducted over the works by Mr. Springer, the engineer on duty.

A Safety Device for Slipping Trolleys.—The device described in the following by our Berlin correspondent, is being constructed by the Elektricitäts Aktien-Gesellschaft, formerly W. Lahmeyer & Co., of Frankfort-on-Maine, Germany, with a view to eliminating the risk of derailments of trolley wheels, which may result in serious injury to the gear. As seen from the accompanying figures, the device mainly consists of a massive disk of cast-iron, resting on a flat iron support. A similar support is fixed to each

Details of Safety Device.

end of the car, above the buffer, the trolley rope being attached by a spring hook in a short chain carried by the disk. Another short chain, which is likewise fixed to the disk, is hooked in the support below the disk, this lower chain being so short as just to allow of the disk leaving the support. The total length of trolley rope, that is, the length of the rope in addition to the above chain, is so



Safety Device in Use.

adjusted by the conductor that the rope is nearly taut at the highest point of the trolley wire. The weight of the disk is designed according to the spring tension of the trolley pole, so as to enable the disk readily to overcome this tension. If, for instance, the wheel presses against the overhead wire with a force of 22 lbs., the weight will have to be about 24 lbs. The working of the device is as follows:—On the trolley wheel being thrown off the wire, the weight, owing to the resulting shock, is lifted from its position. Being able, as pointed out above, readily to overcome the spring tension of the trolley pole, it at once falls down, pulling the wheel below the overhead work. As the lower chain prevents the weight being lifted by more than, say, 5 to 6 cm. above the support, the uppermost point reached by the wheel on the trolley pole being thrown out, will be fixed. The travel of the contact wheel from the overhead wire up to this point is in all cases, even at the lowest point of the overhead wire, so short as to exclude any possibility of the pole or the overhead gear being injured. The above device has been in operation ever since February, 1902, on 15 motor-cars of the Tilsit tramways, giving every satisfaction. Throughout this interval, there has never occurred any injury to a trolley pole, or to the overhead line, attributable to a derailment of the wheel, or to defective working of the safety device. The overhead wire of the Tilsit tramways is 12 km. in length, including 46 overhead switches. The absence of any delicate parts, and the substantial construction of the safety device, deserve special mention.

Catalogues and Lists.—The British Electric Plant Co., Ltd., of Alloa, which is represented in London by Messrs. John Coates & Co., of Suffolk House, Laurence Pountney Hill, E.C., has just brought out some excellently illustrated circulars relating to its four-pole protected machines, high-speed engines, and six-pole generators, six-pole protected motor, six-pole split-yoke dynamo, &c.

The British Electric Transformer Co., Ltd., of Hayes, Middlesex, has favoured us once more with one of its beautifully bound copies of *Whittaker's Almanack* for next year, which is, of all reference books, the most indispensable. The 1904 issue, which has been of great service to us in our editorial department during the past 12 months, has kept the name of the Hayes Co. well before us, and we have no doubt that, in this and many another office, the same effect will be repeated during 1905.

The Simplex Steel Conduit Co, Ltd., send us an extremely neat leather-bound engagement and address book combined, with thumb index, and an accident insurance policy for £1,000, covering 1905. We hope to find it all useful, except the last-mentioned item.

Messrs. A. H. Marshall & Co., electrical engineers, of Leytonstone, are supplying an automatic police light, which acts automatically upon any windows, doors, casements, &c., being forced. The light is fixed outside the building, and is said to remain alight quite unknown to burglars, and cannot be switched off if it is known to them.

We are once more indebted to the Electrical Power Storage Co., Ltd., of Great Winchester Street, E.C., for one of their very serviceable blotting pads with monthly date card slips at the head and a diary for 1905 at the left-hand side. The E.P.S. pad is an old friend, and we are always ready for it at this time of the year. A pocket price list of the E.P.S. storage cells, for the purpose of making rough calculations, has arrived in company with it.

Mr. F. Hope-Jones wishes his friends the compliments of the season on an attractive card, which shows a reproduction from a snapshot of the Electricity Building at the St. Louis Exhibition, where the "Synchronome" system was awarded a gold medal.

Messrs. Pratt & Keith, electrical engineers, of Aberdeen, have published a pamphlet entitled "Hints on Electrical Work," in which they give some particulars regarding their work in power, lighting, heating and other electrical installations, also electric bell and telephone work. Many illustrations of electric motors, water-wheel and steam plants, electric light fittings, radiators, telephones are given.

From Messrs. W. T. Glover & Co, Ltd., we have received copies of their 1905 Almanac. We believe that the arrival of this handy tear-off almanac is looked forward to by the majority of the electrical world, and on this occasion its compiler may be congratulated on a more than usually successful effort. It is arranged on similar lines to those of previous years, the features of well-known central station engineers intermingling with poetical effusions, paragraphs of engineering interest and sketches, while the altered arrangement of the leaves and their improved fastening will be generally appreciated. Members of the I.E.E. will appreciate the feelings which gave a place to the portrait of the late Mr. W. G. McMillan, and all must applaud the plucky attempt which has succeeded in reproducing the familiar—fragmentary—countenance of a well-known metropolitan engineer.

Messrs. Dorman & Smith are wishing their friends the compliments of the season in a quite unique way. It is not a sample of switchgear that has been received, but a specimen of nicely finished brasswork in the form of a leg and foot (2¼ in. long), intended for any of the following purposes: a pipe cleaner, a tobacco stopper, or parcel carrier. The firm, in sending out this little souvenir, is anxious not to "put its foot in it" by wishing a prosperous year's business in 1905.

A handy desk calendar for 1905, with separate monthly cards, has been received from Mr. John Whitelaw, model-maker and electrical engineer, of 15a, Duncan Street, Edinburgh.

A catalogue of the "H. B." tramcar life-guard has come to hand from Hudson-Bowring, Ltd., of Manchester. Four different styles of this guard are detailed and shown.

Messrs. Geipel & Lange, of Vulcan Works, St. Thomas Street, Southwark, S.E., have favoured us with one of their vest-pocket diaries for the New Year. Our copy of the 1904 issue has rendered excellent service, the neat appearance, convenient size, insurance policy, and the engineering tables selected by Mr. Geipel, all combining to make it quite a useful and desirable pocket companion.

Trade Announcement.—The electrical department of Messrs. Bruce Peebles & Co., Ltd., of East Pilton, is closed from to-morrow, December 31st until Tuesday, January 10th, for the purposes of annual audit and stocktaking.

(*Continued on page* 1071.)

ELECTRIFICATION OF THE NORTH-EASTERN RAILWAY.

(*Concluded from page* 1031.)

As in the case of public electricity supply, the feeder and distributor cables form a very important factor in the electrification of railways, as regards both capital outlay and reliability of operation. In the present instance the power is transmitted from the generating station to the sub-stations at a pressure of 6,000 volts, and the whole of the cables are either laid underground or are carried on the walls by the side of the track. The contract for the extra high pressure cables, as well as the telephone, pilot and lighting cables, was carried out by Messrs. Siemens Bros. and Co., Ltd., who also laid them and executed all work in connection therewith.

All the cables, except those provided for telephone purposes, are of the three-core type. The extra high pressure feeders and the lighting cables have segmentally-shaped conductors, insulated with paper impregnated with a special resinous compound, and stranded together with yarn worming, so as to give a circular section. An additional covering of paper is then laid over all, so that the thickness of dielectric between any conductor and the earthed sheathing is equal to that between any two conductors. The earthed sheathing consists of copper strip laid in contact with the lead sheathing, thus complying with the requirements of the Board of Trade.

Right-angle Trifurcating Boxes.

Mains alongside Railway Track, with Troughs filled in and covered with Tiles.

The high-pressure cables were tested with three times the working pressure in each case—viz., 18,000 volts for the extra high-pressure cables, and 6,000 volts for the lighting cables, which work at 2,000 volts. These pressures were applied for 15 minutes between conductors, and between conductor and earth. The cables were also subjected to severe bending and breakdown tests, the latter taking place between 40,000 and 54,000 volts in the case of the extra high-pressure cables, and between 21,000 and 24,000 in the case of the lighting cables. Tests of double the working pressure were applied after the cables had been laid and jointed.

The mains were laid for the most part on the solid system, in creosoted wooden troughs covered with tiles when underground, and in ¼-in. wrought-iron troughs when above the surface. A separate trough was used for each cable, except in the case of the pilot and telephone cables. In the North Shields tunnel the cables are armoured with steel tape, and hung on brackets. Special trifurcating boxes are used for dividing the three-core cables outside sub-stations.

Most of the extra high-pressure cables are of 0·25 and 0·2 sq. in. section, only two being 0·1 sq. in.; the lighting cables are all 0·034 sq. in. in cross-section. The accompanying illustrations show the mode of laying and dividing the cables.

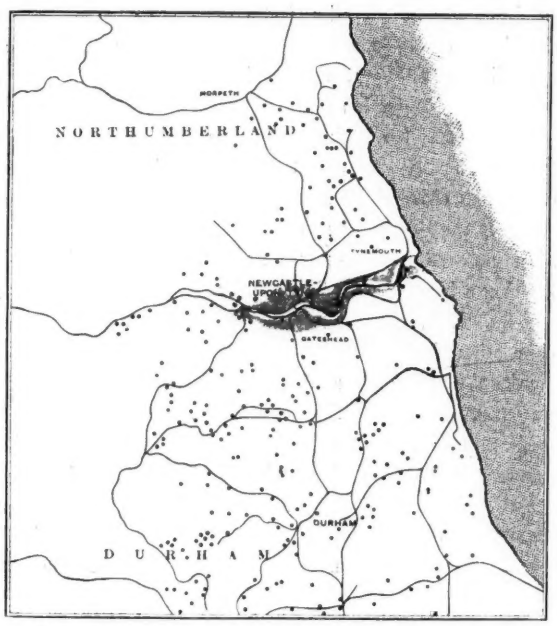
The low-pressure D.C. cables were supplied by Messrs. Callender's Cable & Construction Co., Ltd.

Ouseburn Viaduct: Mains in W.I. Troughing.

It may here be mentioned that the railway company takes electrical energy not only for traction, but also for lighting and power at the same rates, and is therefore able to effect a great saving in respect of these items. Separate cables and transformers being used for this purpose, the continuity of the supply is independent of the operation of the railway; and seven sub-stations for lighting and power are provided, in addition to the five already mentioned. The aggregate capacity of the lighting and power plant is over 7,000 E.H.P., and arrangements are being made for lighting over 30 passenger stations, besides the Central Station and the goods yards, and to equip the numerous capstans, cranes, &c., in the yards and warehouses for electric driving. The locomotive and repair shops of the railway company are already electrically-driven and lighted, and it is anticipated that 1,000 arc lamps, 20,000 incandescent lamps, and 100 motors, aggregating over 2,000 H.P., will be connected. The working pressure is 440 volts between the outers of the three-phase system, giving about 250 volts between outer and neutral.

The generating station from which the supply is mainly derived is the new station at Carville, which is intended to supply not only the railway, but also the city of Newcastle, the Tyneside tramways, and the numerous manufactories on the north bank of the Tyne, nearly all of which are electrically driven from the Newcastle-upon-Tyne Electric Supply Co.'s mains. The load on the latter amounts to over 40,000 H.P., and the factories supplied employ 40,000 hands. Moreover, the company has an arrangement with the County of Durham Electric Power Supply Co. for supplying power to the latter, and there is every probability that within a few years all the requirements for electric lighting, power and traction of the large industrial area in the counties of Northumberland and Durham, as indicated in the accompanying figure, will be supplied from one interconnected system.

The Carville power station is situated on the River Tyne, at Wallsend, not far from the centre of the railway company's present system, or from the supply company's Neptune Bank Station. In the design of the station Mr. Merz adopted the system of complete sub-division of the plant, so as to minimise the possibility of breakdown, each generator being provided with its own boilers, condenser, switchgear and auxiliaries. The reasons which led the engineers to the adoption of this arrangement were fully set forth in their paper on "Power Station Design," read before the Institution of Electrical Engineers last April, and reprinted in our issues of May 13th, 20th and 27th, and June 3rd and 10th; this paper also contained many particulars and drawings relating to the Carville station, to which the reader is referred.

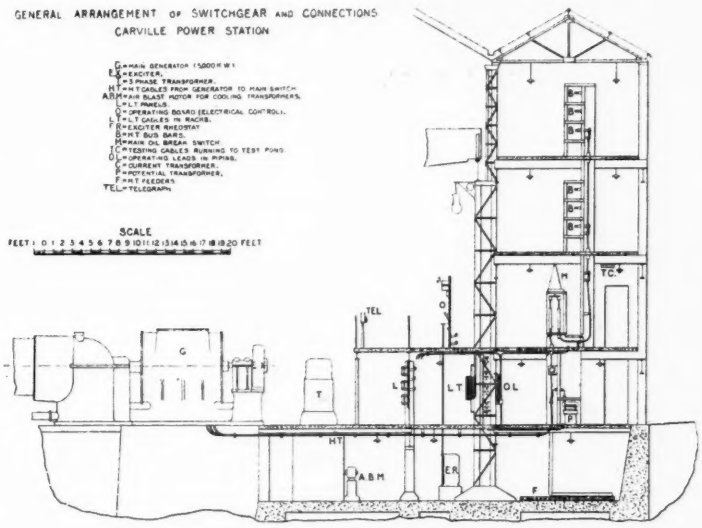


Industrial Centres of Northumberland and Durham.

A view of the interior of the engine room is given herewith, as well as a view of the switchgear, which is of unique design. The generating plant consists of four turbo-alternators—two of 4,000 and two of 2,000 KW. each—built by Messrs. C. A. Parsons & Co., of Newcastle-on-Tyne, generating at 6,000 volts, 40 cycles per second. Each of these is provided with its own exciter, mounted on the end of the shaft, and connected directly with the field magnet winding of the alternator—regulation being effected entirely on the field of the exciter. The turbine type of prime mover was adopted on account

Carville: Interior of Engine Room.

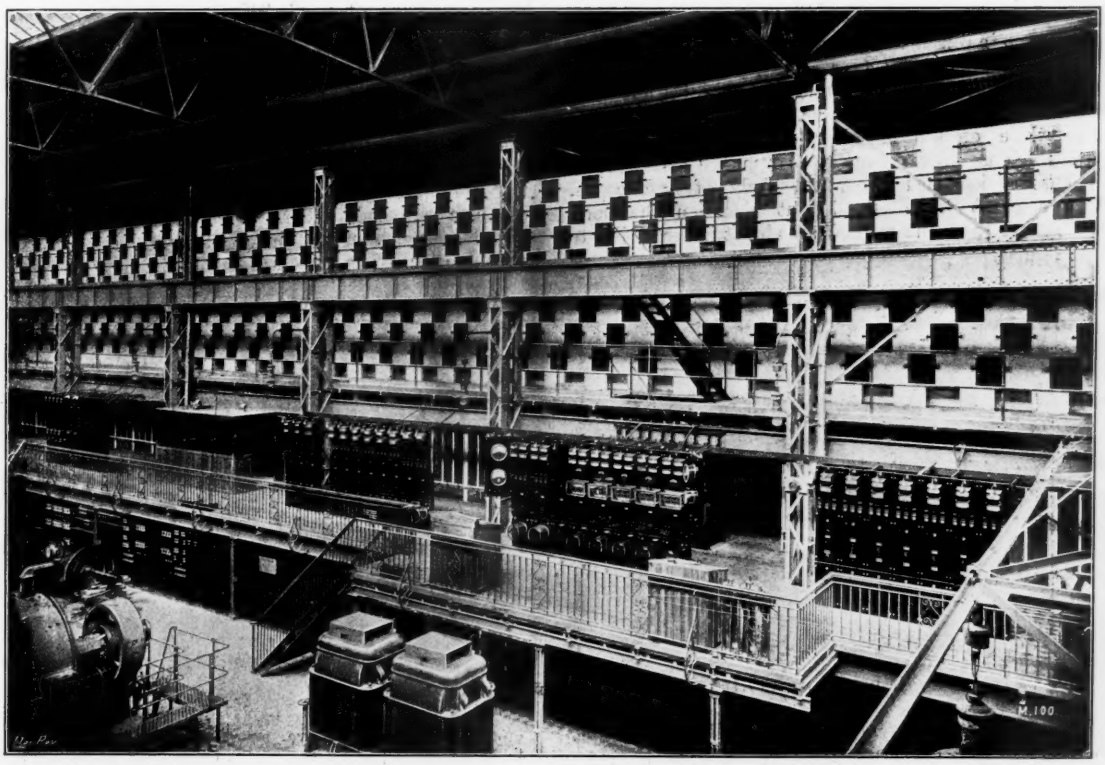
of its low consumption of steam and oil, small cost of repairs and attendance, and low capital cost, the latter being 20 or 30 per cent. less than with reciprocating engines, when the cost of buildings and foundations is taken into consideration. The reliability and simplicity of the turbine had previously been proved to the engineers' satisfaction by the performance of the 3,000-H.P. turbine installed three years ago at the Neptune Bank power station. The overload capacity of the turbine was also a strong point in its favour, a special governor being provided which admits high-pressure steam to the low-pressure portion of the turbine, enabling the latter to carry a load 100 per cent. greater than the most economical load. The tests which have been carried out show that with steam at 200 lb. pressure superheated 150° F., and a vacuum of 95 per cent. of the absolute maximum, the steam consumption will not exceed 15 lb. per KW.-hour at the most economical load, or 16 lb. at any load between 4,000 and 7,000 H.P.



The plant is completely sub-divided from the railway siding—which is at a higher level than the coal bunkers—to the main bus-bars. Each section of boilers contains 10 Babcock & Wilcox marine boilers, of 2,000 H.P. each, this type being chosen on account of the economy of floor space, and the absence of air leakage, the boiler being enclosed by steel plates instead of brickwork. The boilers are arranged in rows at right angles to the length of the engine room, with the economisers and chimneys at the ends of the rows. The turbo-alternators are arranged side by side in the engine room, with their auxiliaries of all kinds alongside, and condensers below the floor level.

On the opposite side of the engine room the switch gear is built, the arrangement being such that crossing of cables is entirely avoided. In front of the switch gear, on a gallery, stands the operating board, from which the whole of the switch gear is electrically controlled. The arrangement of the respective parts of the apparatus is illustrated in the accompanying section, reproduced from the I.E.E. paper above-mentioned; the construction is similar to that of the sub-station switch gear, but here the work was carried out by the British Thomson-Houston Co., Ltd.

In their B.A. paper to which we have already referred, the authors show how much more economical it is, and must be, to obtain power, even for large undertakings such as railways, from power companies whose operations cover a wide area, rather than to erect isolated generating stations of comparatively small dimensions, and it is highly significant that practically all the large manufacturing and industrial concerns in the Tyneside district, including the railway and tramway companies, have recognised this fact, the only notable exception being the Corporation of Newcastle. The authors consider that, in spite of the absence of water power in this country, there



VIEW OF THE SWITCHGEAR IN CARVILLE POWER STATION.

is every reason to believe that, given a fair field, electrical power can be supplied over the greater part of the country more cheaply than in any other country in the world, thanks to the density of the population, the abundant supply of coal, and the nature of the industries carried on. It must be admitted that their work has already gone far towards establishing the truth of this contention in actual practice.

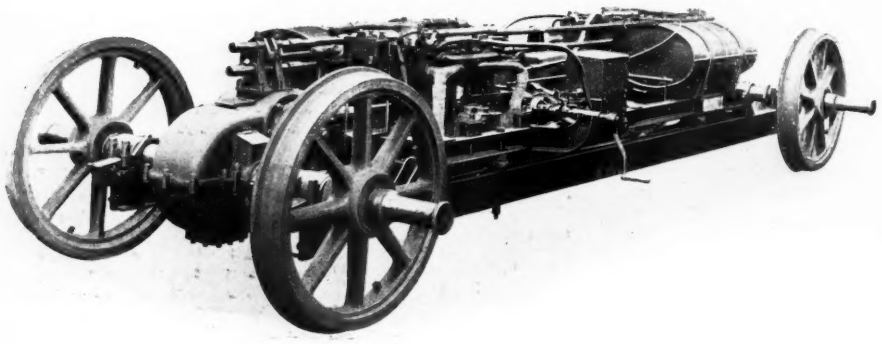
A PETROL MOTOR-CAR FOR RAILWAYS.

The economical operation of short branch lines traversing sparsely populated country has long been one of the most important problems of railway management. It is generally admitted that under such conditions an automobile type of car presents many advantages, and for some time past a good deal of experimental work has been carried on by various railways throughout the country, to determine which type of automobile seems best suited to their peculiar conditions.

While some railway companies have been experimenting with steam automobiles, others have adopted petrol cars, and in one case a combined petrol and electric system has been employed. During the past few months the Great Northern Railway Co. has been carrying out most interesting experiments in this direction with a car specially designed by Messrs. Dick, Kerr & Co. The system of applying two electric motors to a tramcar has been copied in the automobile, two petrol engines being employed, which are connected to a shaft in a manner which will be described.

The seating capacity is 32 passengers, but it is obvious that this can be considerably increased, and the builders are already engaged on a larger type of car, which will not only carry considerably more passengers, but will also provide a certain amount of space for luggage.

The whole of the machinery is assembled upon a frame, which is directly supported from the axles. It is thus entirely insulated from the body of the coach, and as a result while standing at a station the noise and vibration from the engines are almost imperceptible to the passengers.

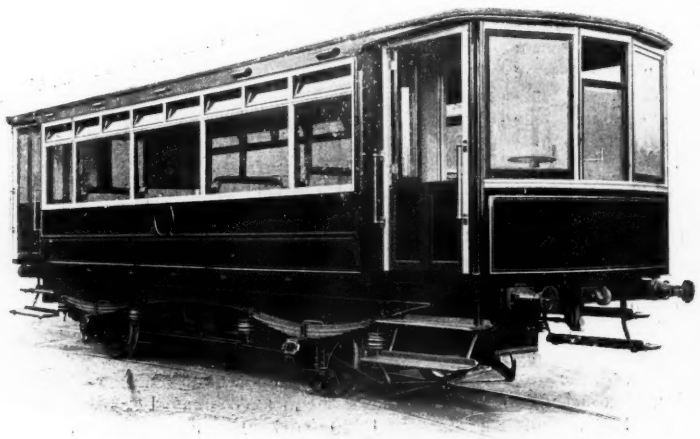


Under-frame and Driving Machinery of Petrol Car.

The motive power is generated by two engines, which, however, are not connected independently to the axles, although both axles are driven; under normal circumstances the engines drive on to a common longitudinal shaft, which is connected to the axles by bevelled gearing. To overcome the difficulty of one axle over-running the other, owing to any possible inequality in the diameter of the wheels, a special form of differential gear is introduced, and combined with this special gear is the reversing mechanism. The engines are connected through independent clutches to a common change speed box, from which the power is transmitted, by means of the longitudinal driving shaft, to gear boxes suspended on each axle, and at this point the speed is reduced by means of single reduction gearing.

The engines are of the standard Daimler type, each capable of developing 36 H.P. when running at full speed. A separate petrol tank is provided for each engine, and the combined capacity of these is sufficient for 400 car-miles.

The complete car weighs something under 16 tons, including its full complement of passengers, and although the normal speed for which it is designed is 30 miles per hour, it has on several occasions attained a speed considerably over 50 miles. The car is lighted by electricity obtained from storage batteries, which also supply energy for ignition purposes and for the magnetic clutches. The



Dick, Kerr Petrol Motor-car.

design of the complete car is such, that by jacking up the body the under-frame and machinery can be run out in the same manner that a truck can be taken from beneath a standard electric tramway car; but, in addition to this, the frame containing the machinery can be lowered from its bearings on the axles without removing the truck from underneath the car body, so that it will be seen that the flexibility and facilities for overhauling and repairs are everything that can be desired. The engines in this case were made by the Daimler Motor Co., of Coventry, who also manufactured the greater portion of the transmission gear. The patents covering the arrangement, however, are entirely controlled by Messrs. Dick, Kerr & Co.

The design of the car and its experimental operation have been under the personal supervision of Mr. Oliver Bury, the general manager of the Great Northern Railway Co.

Softening Boiler Water.—A process has been patented by the firm of H. Reisert, of Cologne, for the above purpose, which consists in adding finely-powdered barium carbonate to the water. This reacts with the calcium sulphate, producing barium sulphate and calcium carbonate, both of which are insoluble. The amount of barium carbonate used does not require measuring; an excess is all that is necessary. Any specific corrosive constituent like magnesium chloride, which is not acted upon by the barium salt, is destroyed by the addition of a suitable chemical which converts it into common salt and magnesium hydroxide. The apparatus employed only needs re-charging once every week or month (according to the "permanent hardness" of the water treated), and emptying about four times a year. The process does not increase the specific gravity of the water or raise its boiling point.

BUSINESS NOTES.

(*Continued from page* 1066.)

Reduction of Capital.—A petition for confirming a resolution reducing the capital of Cryselco, Ltd., from £50,000 to £15,000, is to be heard before Mr. Justice Farwell on January 17th.

Imports of Foreign Electric Apparatus.—While the imports of foreign electrical machinery are on the increase, those of foreign electrical goods and apparatus appear to be declining. Thus the value of such imports during November last only amounted to £75,485, as contrasted with £82,944 in the corresponding month of 1903. For the 11 months ending with November last the returns show a total of £704,563, as against £732,088 in the first 11 months of 1903.

Electric Crane.—Messrs. William Arrol & Co. are erecting a 150-ton electric crane at the ship-building yard of Messrs. John Brown & Co., Clydebank.

Ozone.—A new company has been registered with the title, "Ozone, Ltd.," with a nominal capital of £50,000, to acquire an invention relating to the generation of ozone, &c.

Annual Dinner.—The officials and staff of Messrs. Ernest Scott & Mountain recently held their annual dinner at Newcastle-on-Tyne, Mr. W. C. Mountain, managing director, presiding. In responding to the toast, "Success to the firm," Mr. Mountain referred to the new works, the pattern shops and foundry of which will start operations at the New Year. In reference to the question of foreign competition, he said that in every contract for which he tendered he was faced by offers from firms in Germany and America, especially the former. He did not think it fair that foreigners should send their materials into this country free. He hoped that everyone would assist in bringing about the state of affairs wished for by Mr. Chamberlain.

The Chemical Trade in 1904.—It is satisfactory to learn that the chemical trade of Great Britain has more than maintained its position during the past year, notwithstanding the depressed condition of the textile industries and foreign competition. Exports show no sign of falling off, and imports have increased over 5 per cent. In heavy chemicals there is not much change to record. Contracts for caustic soda have been made over next year at 5s. per ton lower, but bleaching powder shows an advance of 5s. to 7s. 6d. Notwithstanding American competition, the export of English-made sulphate of copper shows a steady advance both in quantity and value, and at present, owing to the recent rise in the raw metal, the manufactured article has shown a strong upward movement, and makers are not inclined to book forward except at full rates.—*Financial Times.*

Dissolutions and Liquidations.—The creditors and shareholders of the Sir Hiram Maxim Electrical and Engineering Co., Ltd., met on Wednesday last week at the Holborn Restaurant to elect a liquidator and committee of inspection to act under the compulsory winding-up order made against the company on November 29th upon a creditor's petition. Mr. Cully, Assistant Receiver, reported that the company was formed in May, 1899, with a capital of £100,000 to acquire the sole agency for the sale in Australasia, Africa and Asia, of the electrical appliances and all articles manufactured by the Hiram Maxim Electrical Corporation, Ltd., and by J. F. Pease & Co, Ltd., of Middlesborough-on-Tees. In February, 1901, the capital of the company was increased to £175,000, and in September, 1903, it was further increased to £190,000, the present issued capital being £170,399. The remuneration of the directors was fixed at 10 per cent. of the net profits earned by the company, but no fees had been drawn by them. No prospectus was issued to the public; a few copies were printed, but not issued for the purpose of obtaining subscriptions. The consideration paid by the company was fixed at £80,000, and was paid in shares. The company started trading with an available working capital of £20,000. In October, 1900, they acquired for £2,000 cash the business of Messrs. Edward & Barnes, and in the following January they purchased for £55,200 in cash and shares the undertaking of the Hiram S. Maxim Electrical Corporation, Ltd. Then in June, 1901, the Hiram S. Maxim Lamp Co., Ltd., was formed by a previous employé, and an agreement was entered into under which the Lamp Co. were to have the exclusive sale of the Maxim lamp. Difficulties arose between the two boards of directors, and in August, 1903, the company acquired all the goodwill and business of the lamp company for £1,390. In November, 1902, £14,750 was raised on debentures. The company in March, 1904, acquired from Sir Hiram S. Maxim his patent rights relating to captive flying machines, the purchase consideration being £6,666 in shares of the Hiram S. Maxim Captive Flying Machine Co., Ltd, which was promoted with a capital of £30,000. Several thousands of the Flying Machine Co.'s shares had been sold at par. The insolvency of the company was ascribed to the falling through of the agreement with the Hiram Lamp Co., the shortness of working capital owing to the available working capital being locked up in lamp stock, and to adverse legal costs. On October 21st, 1904, Mr. Arthur Hardie was appointed by the board as Receiver for the debenture-holders, and had since carried on the business for the purpose of completing several valuable contracts. Accounts had been lodged showing unsecured debts £29,804, debenture claims £20,305, and assets valued at £57,814, or sufficient to yield a surplus of £7,704. He understood that a reconstruction scheme was contemplated, and in that case it would be desirable to appoint an outside liquidator. Mr. Hardie said a considerable amount of capital had been sunk, but the difficulty had arisen in not having more capital at a time when the business was largely increasing. The company's prospects were very good, and it had a valuable business which ought to be preserved for the benefit of all concerned. Sir Hiram Maxim addressed the meeting, and explained that, owing to the bad state of his health, he had been out of England during the greater part of the company's existence, and he consequently had very little knowledge of its management. He had invested a considerable amount of money in the company, and had not received a single shilling in return. Mr. A. F. Whinney and Mr. Arthur Hardie were respectively nominated for the post of liquidator, and the chairman intimated that the appointment would be made in due course by the Registrar. The following creditors were selected to act as a committee of inspection, viz.:—Mr. Charles Rimmer, Mr. James Rawson, Mr. E. L. Pinchin, and Mr. C. F. Ince. The following are the largest creditors:—

Unsecured.

G. Braulik, London	40	1	8
Concordia Electric Wire Co., London	71	1	2
Davis & Timmins, Ltd., London	57	3	8
Glasshüttenwerke Weisswasser, &c., London	51	2	0
Highton & Co., London	54	15	11
C. F. Ince, London	117	2	6
Johnson, Matthey & Co., London	448	12	10
Jaeger Bros., London	44	14	2
J. Kirkby, London	61	2	8
London Electric Supply Co.	82	8	7
Melin & Co., London	73	3	2
J. Planchon, London	75	11	11
Smith & Sons, London	46	5	3
Sturtevant Engineering Co., Ltd., London	56	0	1
Vitite Works, Ltd., Middelburg, Holland	65	11	8
A. Watson & Co., Birmingham	41	7	4
Acme Steel and Foundry Co., Lanark	66	8	9
Daniel Adamson & Co., Dukinfield	96	18	10
Bilbie, Hobson & Co., London	150	4	9
J. & C. Bowyer, Upper Norwood	643	16	3
J. Blakeborough & Sons, Brighouse	119	17	0
Worthington Pump Co., London	49	0	0
Edmond Collins, London	56	18	10
Crouch & Jay, London	51	4	2
Durrance & Co., London	84	9	4
The *Electrical Press*, Ltd., London	75	19	9
Charles A. Webb, Chatham	239	3	6
Joseph Fielding & Sons, Blackpool	126	10	10
Glenfield & Kennedy, Ltd., Kilmarnock	547	15	2
Giepel & Lange, London	197	6	1
Groom & Co., Ltd., London	165	2	5
R. Gay & Co., Ltd., London	50	5	6
O. Haacke & Co., London	102	2	1
Thomas Hart, Blackburn	54	14	7
Hayward, Tyler & Co., London	54	4	9
England & Co., London	41	5	0
Matthew Keenan & Co., Ltd., London	76	3	6
The Lister Electric Manufacturing Co., Ltd., Dursley, Glos.	468	5	9
Thomas Noakes & Sons, London	231	18	3
James Phillips & Co., London	111	10	8
E. J. Robinson, Ltd., London	762	18	6
Stewart & Lloyds, Ltd., Glasgow	44	19	1
Sharpe & Co., Lancaster	90	17	11
The Widnes Foundry Co., Widnes	1,222	17	10
Wallerman Bros., Hyde	58	13	6
Reid, McFarlane & Co., Ltd., Plaistow	47	4	8
A. W. Hill, Chiswick	305	0	0
Wright Bros., London	353	6	8
Frank Varley, London	250	15	1
Jones & Horsfield	245	18	6
Stevens & Sons, London	82	10	0

Messrs. J. T. Mayfield and Thomas Champness (J. T. Mayfield and Co., electrical engineers, 63, Cannon Street, E.C.) have dissolved partnership. Mr. Mayfield will attend to debts.

A petition for winding up Peter Pilkington, Ltd., of Bamber Bridge, as presented by Messrs. J. B. Hallmark & Sons, Ltd., ironmongers, of Preston, is to be heard at Liverpool, on January 11th.

Book Notices.—*Willing's Press Guide*, 1905.—This is the thirty-second annual issue of this work (published at 125, Strand, W.C.), and it is so well known a shillingsworth that hardly anything need be said to commend it. It has a useful alphabetical list of newspapers, magazines, trade journals, directories, &c., published in the British Isles, and a classified section as well. Another feature is the lists of principal Colonial and foreign journals, though in so small a compass, this list cannot be made anything like complete. We always like to keep our *Willing's* ready at hand.

"The Physical Review," December, 1904, No. 6, Vol. XIX. New York and London: The Macmillan Co.

"Armorduct."—"Armorduct" conduit has been used for the electric lighting installation of the new Coliseum and the Haymarket Theatre.

Bankruptcy Proceedings.—At Stoke-on-Trent, on 19th inst., Harry Cooke, electrical engineer, Longton, appeared before Mr. J. C. Marshall, Registrar, for his examination upon a statement showing liabilities to the amount of £244 and a deficiency of £225. The examination was closed.

A Rochdale Power Plant.—Messrs. Turner Bros. have just completed some important extensions at their asbestos and belting works at Spotland. A feature of the extension is the installation of an electric driving plant. The equipment consists of two 150-H.P. multipolar continuous current generators, driving direct from horizontal compound steam engines. The whole of the power is transmitted some considerable distance from the generator to the rubber department, where it is distributed to drive the machinery. There are two electric motors capable of developing 75 H.P. each, geared directly to two sets of rubber-working machines and as the process of working the rubber is very severe and requires a great

amount of labour, safety cut-out switches have been provided on each of the motor panels to prevent damage being done to the motors, in case of the work being applied in too severe a manner. In another part of the department a third 75-H.P. motor is put down, geared through ropes to some line shafting distributed over the department for the purpose of driving various smaller machines. The whole of the power plant has been installed by the Rochdale Electric Co., Ltd., of Shawclough, the large motors being made by them at their works.

LIGHTING AND POWER NOTES.

Adare.—It is stated that the Earl of Dunraven is about to light his Co. Limerick residence at Adare by electricity, and that he contemplates lighting the village by the same illuminant when the installation at the Manor is complete.

Barnes.—The clerk to the D.C. reports that the assessment on the electricity works has been increased from £400 to £948 by the Assessment Committee. It was resolved to make inquiries into the matter.

Barrow-in-Furness.—The L.G.B. has sanctioned the borrowing by the B.C., of £35,000 for extensions at its electricity works. The extensions comprise an addition to the engine room of 53 ft. 6 in. × 48 ft. 6 in., and to the boiler house of 76 ft × 48 ft., a 500-KW. generator, switchboard, two water-tube boilers, a condenser, piping, &c. The space will provide for two more 500-KW. generators, and two additional boilers. When the present extensions are carried out, the capacity of the undertaking will be 1,525 KW. The plans and specifications for the engineering part of the work have been prepared by the electrical engineer, Mr. H. R. Burnett.

Bexhill-on-Sea.—The T.C. has received the sanction of the L.G.B. to the borrowing of the £3,400 of the £3,500 applied for, for electric light purposes. It has also been decided to hold an electrical exhibition in the borough, and the T.C. has sanctioned an expenditure of £50 for this.

Bradford.—Mr. A. S. Blackman, in his report on the recent stoppage in the supply of electricity, recommends the making of the cable sheaths continuous, and the comprehensive scheme of fusing, including dividing the town network into four districts. The cost is estimated at £2,970, and he advises that the work be proceeded with immediately. Separate switches and fusing arrangements are recommended at the Bolton Road works for the interconnector mains.

The Electricity Committee of the Chamber of Trades has drawn up a memorial addressed to the Corporation Electricity Committee requesting the adoption of a sliding scale of charges for electric lighting, and asking that instead of giving the consumer free lamps, the Committee should allow a small discount. It was stated that there was inequality in discounts, some getting 10 per cent., and others, who were equally large users, getting no discount.

Conway.—The T.C. has resolved to apply to the B. of T. for a prov. order for E.L., and has decided not to expend a larger sum than £15,000 on the scheme.

Dunfermline.—The T.C., at a special meeting held on the 22nd inst., had under consideration the question whether it should erect a generating station and supply electricity itself or negotiate with the Fife Electric Power Co. to get a supply. It was ultimately agreed to make arrangements for applying for a prov. order, and, at the same time, to re-open negotiations with the Electric Co.

Ebbw Vale.—The Council has approved of the draft agreement submitted by the Ebbw Vale Co., with reference to a supply of electricity for lighting purposes, and it is also approved by Mr. Wilson, electrical engineer to the Council, with the exception of a clause providing that the delivery of energy should be given at one place instead of three. It was decided to negotiate for the amendment of the agreement to the effect that delivery be arranged for at three centres.

Erith.—A L.G.B. inquiry has been held into the U.D.C.'s application for a loan of £20,000 for electric lighting purposes. The loan is made up as follows:—Excess expenditure over loans, £5,978; new buildings, £2,500; transformer house at Belvedere, £200; switchgear at Belvedere, £100; transformer building at Erith and transformers, £500; mains extensions, £462; mains, £3,500; transformers, £1,500; meters, £1,200; electric fittings, £300; motors, £700; contingencies, £631 18s. There was no opposition.

France.—An electric power plant is to be put down at the works of La Société des Toleries de Louvroil, at Maubeuge.

Fremantle (W.A.)—The chairman of the Harbour Trust has conferred with the Electric Tramways Board, with reference to a supply by the latter of energy for lighting the wharves and the working of the cranes by electricity. The price has not yet been fixed.

Germany.—A central electric lighting station is to be established in the little town of Pinneberg (Holstein).

Glebe, N.S.W.—The T.C. has introduced a Bill into Parliament for authorisation to its putting down a combined E.L. and refuse destructor plant, and to borrow money to carry out the scheme. The powers sought include the supply of energy to adjacent municipalities, as well as to the ratepayers in its own district.

Grimsby.—At the recent meeting of the Lighting Committee, sanction was received from the L.G.B. to the borrowing of £3,000 for the extension of mains, and the purchase of meters in connection with the electricity works for the next twelve months.

H.M.S. "Britannia." — The electrical plant to be installed aboard this first-class battle-ship, launched recently at Portsmouth, will comprise four generators, supplying 600 amperes at 105 volts, with a speed at 400 r.p.m. In addition to lighting the whole of the ship, electrical power is to be used for driving the ventilating fans, the ammunition hoists, winches and capstans. Colomb lamps have been installed for lighting purposes, when the generating plant may be shut down. Electric bells and navyphones are to be fitted for communication between conning tower, engine room, and gun positions, &c.

London.—The *Financial Times* says that the East London and Lower Thames Electric Power Bill, which will be brought up again in the forthcoming Session in an amended form, forecasts the promotion of a company, with a capital of £2,000,000, in 200,000 shares of £10 each, of which £100,000 is to be subscribed before the Act can be put in force. The area of supply scheduled has already been mentioned in the ELECTRICAL REVIEW.

ST. PANCRAS.—The L.C.C. has agreed to sanction the borrowing of the sum of £7,515 by the B.C. for its E.L. undertaking.

CHELSEA.—Last week the L.G.B. held an inquiry into the application of the B.C. for the loan of £29,000 for the purpose of new baths, which included £2,600 for the provision of electrical plant for lighting. Mr. P. Still, engineer to the Chelsea E.S. Co., opposed the Council putting in a private plant on the ground that it would be a waste of public money. The company had offered most reasonable terms for a supply from their mains. Evidence was given on the management of two of the largest baths in London where generating plants were originally put in, and eventually discarded in consequence of the high cost of maintenance.

Loughborough.—The T.C. has appointed a committee to consider the advisability of lighting certain areas of the town by electricity.

Manchester.—During the fog last week there was an abnormal consumption of energy, chiefly for lighting purposes. On Monday the supply was 196,020 units; on Tuesday, 205,220; on Wednesday, 209,100; and on Thursday, 214,570. These constitute record figures.

Mexico.—The new central station of the Compagnie Mexicaine de Gaz et de Lumière Electrique, in the San Lazaro district of the city of Mexico, has just been inaugurated. The plant has a capacity of 6,000 H.P.

Oldham. — Recently a Local Government Board inspector attended at the Oldham Town Hall to inquire into an application by the T.C. for power to borrow £48,114 on account of the electricity undertaking. Opportunity was given for a good deal of criticism; the Master Cotton Spinners' Association the Engineering Associations and the Lancashire and Yorkshire Railway Co. being represented. In the course of the inquiry the Inspector said he noticed that £11,838 had been spent on the Greenhill electricity station, besides £2,937 on extra routes, and £17,184 on mains. The town clerk pointed out that the total assets of the Corporation up to March 25th last were £4,090,761, and liabilities £3,019,147. It transpired that the total cost of the chimney at the Greenhill station was £4,700. The attention of the Inspector was drawn to an item of £565, which included the cost of photographs, souvenirs, &c., among the latter were a number of gold watches, silver brooches, and other things. The Inspector said these matters were new to him and he would certainly want details. He adjourned the hearing in order that they might be furnished.

Penrith.—A section of the ratepayers held a meeting recently and protested against the U.D.C. scheme for putting down an electricity supply undertaking.

St. Albans.—The St. Albans and District E.S. Co. has received the sanction of the R.D.C. to its application for an E.L. prov. order for the district, and also to a site being obtained in the rural district.

Scarborough.—The Scarborough Electricity Supply Co. has given notice that from January 1st next the price of energy for lighting will be reduced to 6d. per unit with substantial discounts according to the amount consumed. Consumers whose accounts amount to £75 and over, have the option of the maximum demand system with rates of 7d. for the first hour, and 3d. after, with 5 per cent. discount. For power and heating the price is reduced from 2½d. to 2d. per unit, less 5 per cent. discount.

South Wales.—The South Wales Electrical Power Distribution Co. has entered into a provisional agreement with the Carmarthenshire Electric Power Co., to take over all the powers conferred by Parliament in 1903, on the latter. The agreement is made subject to the assent of Parliament being given to the amalgamation and to the assent of three-fourths of the shareholders in both companies passing a special confirmatory resolution.

Stirling.—The T.C. has been holding an electrical exhibition, at which electrical heating and cooking were demonstrated. Among the exhibitors were the Dowsing Co., Messrs. Veritys, Ltd., the British Prometheus Co., the General Electric Co., Drake & Gorham, &c.

Stratford-on-Avon.—The T.C. on the 19th inst. decided to apply to the B. of T. for an extension of time in regard to its E.L. order of 1901 for laying the mains in the compulsory area, and to allow the transfer of powers to the Birmingham Installation Co. The agreement with the company was sealed. The company agreed that the charge for lighting streets and other public places should not exceed 2½d. per unit, for power purposes 3d., and for private lighting 5d. The Corporation has the right to purchase, at the expiration of 11 years, at a figure equal to the previous five years' profits, plus the valuation of the works.

Wellingborough.—By the casting vote of the chairman, the U.D.C. has decided to extend the notice to the electric lighting company, of termination of the present agreement with the Council, by a year.

Worthing.—On the 20th inst. a L.G.B. inquiry was held into the application of the T.C. to borrow £1,600 for extensions to the electric lighting system.

TRAMWAY AND RAILWAY NOTES.

Bristol.—The Bristol Tramways Co. has arranged to place boxes on its cars to receive contributions towards wiping off last year's deficit (£5,400) on the working of the Bristol Royal Infirmary. The President of the Infirmary (Sir George White) is a brother of the managing director of the Tramway Co. It is estimated that if each box contains 1s. per day throughout the year, the deficit will be cleared off.

Chesterfield.—On 20th inst. the Board of Trade inspection of the municipal electric tramways, which have cost £60,000, was made by Major Pringle and Mr. A. P. Trotter. The service was to commence on Saturday last.

Fremantle (W.A.).—From a recent issue of the *Australian Mining Standard*, we learn that the Fremantle (W.A.) Electric Tramways Board has authorised the supervising engineers (Messrs. Noyes Bros.) to purchase material to the value of £58,857, which amount includes all the requisitions signed up to date for general construction, materials, and rails. The rails were ordered some time ago from America. The Board has impressed on the engineers that it desires, as far as practicable, that the materials should be purchased locally, and in furtherance of the Board's wish, a trial order for the construction of one car or more is to be placed with a local firm.

London United Tramways.—A tramcar collision occurred about nine o'clock on Monday night at Hillingdon Hill, a steep gradient about a mile from Uxbridge. A car proceeding from Uxbridge collided with a trap, with the result that three cars were brought to a standstill on the single line. At the top of the hill, some distance away, a fourth car from London dashed into a fifth, driving it down the hill at great speed. Both rushed with great violence into the three cars standing at the bottom. The impact was so great that one of the vehicles was thrown right across the track, and the others were more or less badly smashed. There were very few passengers, but a driver was seriously hurt. The line (says the *Daily Telegraph*) was obstructed for the remainder of the night, and was not cleared until early on Tuesday morning.

Rochester.—The new electric tramways have just been opened to the public. The present line, which runs from Star Hill, Rochester, over the New Road, and joins the Chatham Lines, is only the beginning of an extensive system, that is to cover the whole district of Rochester, Borstal, Strood and Frindsbury.

Sheffield.—The takings from the city tramways in fares for the year just ended, amounted to £235,939. A local paper says that during the past quarter there has been a considerable drop as compared with the three months ended September 30th, but all the returns show a decrease for the concluding quarter of each year. During the past three months there was never one week when the takings reached £5,000, probably owing to the fact that trade has been bad, and that there has been no holiday included.

Spain.—Application has been made for a concession in respect of a projected system of electric tramways in the town of Vigo.

Swansea.—The Corporation is promoting a Bill in the next session of Parliament for powers to acquire the undertaking of the Swansea Improvements and Tramways Co. If the Tramways Co. so desires, the Corporation will grant to the company a lease of the tramways for a period expiring on February 28th, 1927.

Wigan.—On Boxing Day an accident occurred on the Pemberton section of the Corporation tramways. An electric car was proceeding in the direction of Pemberton from Wigan, and when it reached the Halfway House district, the car entered a loop and left the rails at the curve, crashing into a fruit shop. The front of the premises was demolished and the car was smashed in front. The driver was injured, but the passengers escaped.

TELEGRAPH AND TELEPHONE NOTES.

Aberdeen Telephones.—It is stated that the N.T. Co. is about to undertake the improvement of the telephone service—including the laying of underground lines—at a cost of about £50,000. An agreement as to terms has been practically accepted by the T.C., on the lines of that between the company and the Edinburgh Corporation.

An Alaska-Siberia Telegraph System.—The following interesting article appeared in the *Times* of December 24th from an "American correspondent":—

"Cable and telegraphic communication between the United States, Siberia, and Japan, China, the Philippines, Korea, Manchuria, and also with the Continent of Europe, is the latest proposal. This idea is put forward by Mr. John Rosene, of Seattle, Washington, who is the managing director of the North-Eastern Siberian Co. He proposes that if the United States Government will extend its line from Nome to Cape Prince of Wales, and establish the wireless system at this point, connecting it with a station at East Cape, the nearest point on the Siberian side, his company will build an overland line across North-Eastern Siberia, for which it holds a concession from the Russian Government, connecting with a line on the Siberian Railway. Mr. Rosene is convinced that such a line could transmit messages from any point in the United States to the Asiatic countries reached for far more reasonable tolls than are now charged by cable companies.

"This brief announcement adds interest to the annual report of General A. W. Greely, chief signal officer to the Secretary of War, on the growth and development of the Alaskan system of telegraphs. The pioneer work was done in 1865, when, before the successful completion of the Atlantic cable, the need for telegraphic communication with the Old World was pressing. Percy McDonald Collins then started an enterprise which contemplated the construction of land and cable lines reaching from Vancouver up to the north-western tip of the Continent, thence across Bering Strait and Siberia to Moscow. Government concessions were obtained, funds were provided, and several exploring and construction parties were sent out. Work on the overland line was carried on for a year, and about 525 miles of the cables necessary for the Bering Sea section were constructed. But with the final laying of the Atlantic cable this bold enterprise was killed for the time, and so was abandoned. It has now been taken up under entirely different circumstances and auspices, and it is likely that it may be finished by the aid of the new developments since made in telegraphy.

"When the United States Government began to give some serious attention to its new acquisition in Alaska the Signal Service took up the matter of telegraphs. By the insistence of General (then Lieutenant) Greely, the Government declined to adopt the policy of purchasing all the telegraph lines in Alaska, but utilised them on a systematic plan, so that by landlines, cables, and wireless, all the military stations should be brought into communication with the nearest army headquarters. This work has now been completed, and General Greely thus refers to the system in some detail:—

"'Its totality also comprises elements not elsewhere combined in a single system—submarine, land, and wireless methods, all worked as one component and harmonious system. The entire construction of 3,738 miles includes not only 2,127 miles of cable, and 1,504 miles of landlines, but also a wireless system of 107 miles. The United States has brought South-Eastern Alaska, the Yukon Valley, and the Bering Strait region into telegraphic communication with the rest of the civilised world. There yet lacks to complete the dream of half a century, of telegraphically uniting America and Asia *vid* Bering Strait, a cable to the Asiatic shore, and a Russian landline of about 1,500 miles to Nikolaievsk.

"'The signal corps wireless station at Nome could communicate with a similar station on the Kamchatka coast, but the infertile and sparsely inhabited country thence to the nearest Russian station of Nikolaievsk renders such an enterprise unlikely. It is important to note that the completion of the Alaskan lines perfects the military intercommunicating system of the United States. The President, or Secretary of War, can now reach, over strictly American lines of telegraph and cable, every important military command from the icy waters of Bering Strait to the tropical seas of the Sulu archipelago, with the exception of the Legation Guard at Peking.'"

The Telegraph Cable Export Trade.—A very quiet state of affairs continues to prevail in the export trade of this country in telegraph cables and apparatus connected therewith. The shipments in November last attained a value of only £95,091 as against £145,271 in November, 1903, in itself a quiet month. The extent of the depression is well shown by the returns for the 11 months ending with November, during which period the exports have amounted to only £791,799 as contrasted with £1,764,899 in the corresponding period of 1903, and £2,729,314 in the first 11 months of 1902.

Wireless Telegraphy.—The *Standard* states, in reference to the North Sea Commission, that the British authorities informed the Russian Ministry of Marine, through Sir Charles Hardinge, that it was desirable that the records of the wireless telegraphic messages exchanged between the vessels of Admiral Rojdestvensky's fleet should be produced to the Court, as important questions might arise upon them. The Admiral sent them home from Libreviele.

The *Daily Telegraph*, of 28th inst., contains a long leader on the Atlantic weather service by wireless telegraphy and the "results and anticipations." It also publishes a map of a large portion of

the Atlantic, the area from which come nearly all our storms and all our calms.

A quotation from the report of the Committee appointed by the Prime Minister to consider the reorganisation of the Meteorological Department is reproduced, in which the experimenting with a wireless service is recommended without unnecessary delay, and it (the *Telegraph*) proceeds to say "it was not difficult to imagine how Ministers would construe the words 'no unnecessary delay,' and that, without being disrespectful to the Governments, Liberal and Conservative alike, they can never be accused of precipitancy where the interests of science are concerned."

The Editor of the *Telegraph*, therefore, took the matter "in hand at once."

The *Standard* states that, according to the *Patria*, Rome, negotiations have been entered upon by the Italian Minister of Posts and Telegraphs and the British Postmaster-General with a view to establishing wireless telegraphic communication between the stations of Poldhu and Bari.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1)	Aug. 26, 1901	
Trinidad-Demerara (No. 2)	Dec. 18, 1904	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	
Tarifa-Tangier	Jan. 18, 1904	
Closed { Vladivostock-Nagasaki	Feb. 9, 1904	
Closed { Port Arthur-Chefu	Mar. 9, 1904	
Paramaribo-Cayenne	July 13, 1904	
Sitka-Valdez	Nov. 11, 1904	
Falmouth-Bilboa	Dec. 14, 1904	Dec. 21
Cape Haiti-Puerto Plata	Dec. 25, 1904	
Bathurst-Sierra Leone	Dec. 27, 1904	
Aseab-Perim	Dec. 26, 1904	
St. Vincent-S. Thiago	Dec. 27, 1904	
Landlines.		
Cartagena-Baranquilla	Dec. 8, 1900	
Puerto-Barrios	July 28, 1902	
via Bhamo	Oct. 15, 1904	Dec. 23
Kertch-Soutchoum	Sept. 27, 1904	
via El Arich	Dec. 23, 1904	Dec. 24

Wire Thefts.—It appears from the *Journal of the Telegraph* that the Western Union Telegraph Co. are experiencing considerable trouble from wire thieves, and that success is attending their criminal prosecutions, one delinquent being awarded seven years' imprisonment. Besides, the company is offering £5 reward for information leading to the arrest and conviction of the thieves. Telephone, electric light, power and railway companies, are equally affected by thefts.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—January 12th. The Public Health Committee is inviting tenders for an electric light installation (engine, dynamos, &c.) for the new Infectious Diseases Hospital, Purdysburn. Specifications (10s.) from the Town Clerk.

Ashton-under-Lyne.—January 17th. Overhead tramways equipment. See "Official Notices" to-day.

Belgium.—Tenders have just been invited by the municipal authorities of Charleroi for the supply and installation of the transformers and mains required in connection with the electric lighting of the town.

Great Western Railway.—January 3rd. Conductor rails, insulating supports, copper bonds, &c., for the electrical equipment of the Hammersmith and City Railway. See "Official Notices" December 9th.

Hull.—January 2nd. The Public Libraries Committee of the Corporation invites tenders for the necessary electric light installation and fittings required at the Carnegie Library, West Park, Anlaby Road. Joseph H. Hirst, City Architect, Town Hall.

Johannesburg.—January 26th. Vignoles rails, fishplates, rails, bolts, nuts, &c. See "Official Notices" December 23rd.

Johannesburg.—March 6th. 100 electric cars, two electric water cars, five-ton crane, car traverser, and workshop tools, for the Municipal Council. See "Official Notices" to-day.

London.—January 16th. Tenders for a 750-kw. steam alternator with pipe connections, &c., for the South London Electric Supply Corporation, Ltd. See "Official Notices" December 23rd.

London.—January 24th. Fire alarm installation for the Northern Hospital, Winchmore Hill, N., for the Metropolitan Asylums Board. See "Official Notices" to-day.

Port Elizabeth.—January 16th. Water-tube boilers, 400-kw. turbo-dynamos, mains, battery and boosters, switchboard, crane, public lighting, meters, workshop equipments and other plant, &c., for the Electricity Supply Undertaking. See "Official Notices" December 16th.

Porto (Portugal).—March 15th. The Town Council has opened a competition for the concession of the exclusive right of the working of the tramways for collective transports of passengers, luggage, and goods in all the municipal public ways. The conditions of the competition are published at the Portuguese Consulate in London.

Pudsey.—January 20th. Underground mains, junction boxes, switchboard, &c., for the Corporation. See "Official Notices" December 16th.

Roumania.—January 28th, 1905. Tenders are being invited by the municipal authorities of Guirgin for the concession for the electric lighting of the town.

Shanghai.—March 31st, 1905. Construction and working of 24 miles of electric tramways on the trolley system, double or single. See "Official Notices" October 14th.

Spain.—January 10th. The Spanish Ministry of Public Works in Madrid is inviting tenders until January 10th for the construction and working during a period of 60 years of an electric tramway between Azcoitia and Zumaya (province of Guipuzcoa). Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Obras Publicas, Madrid.

Sunderland.—December 30th. Wooden cooling towers for the Electricity Department. See "Official Notices" Dec. 16th.

Swindon.—January 24th. One 30 ft. × 8 ft. Lancashire boiler, with superheater, piping, &c. See "Official Notices" to-day.

Whitechapel.—January 16th. The electric lighting of Section 2 of the Infirmary for the Guardians. See "Official Notices" to-day.

CLOSED.

Cardiff.—The E.L. Committee last week considered tenders for new plant for the extension of the Roath power station, which is to be made to meet the increased demand for electric lighting in the town. The following tenders were accepted:—Two 1,600-i.h.p. engines with extras, Messrs. Musgrave and Co., Bolton, £14,304; two 1,100-kw. generators, the General Electric Co., Birmingham.

Kingston.—The T.C. has accepted tenders from Messrs. Siemens Bros. & Co., and Henley's Telegraph Works Co. for cable, at £174 and £115 respectively.

Southend-on-Sea.—The T.C. has accepted the tender of Messrs. Wimhurst, Hollick & Co. for the supply of an electric crane, at £415.

FORTHCOMING EVENTS.

Thursday, January 5th.—At 8.15 p.m. Röntgen Society. Meeting at 20, Hanover Square, W.

At 8 p.m. Rugby Engineering Society. Mr. R. Watson on "Pattern Making."

Tuesday, January 10th.—At 8 p.m. Institution of Civil Engineers. Address by Sir Wm. H. White, K.C.B., &c., on "The Recent Visit to the United States and Canada."

Wednesday, January 11th.—At 7.30 p.m. Association of Engineers-in-Charge. "Gas Producer Plant and Gas Engines," by Mr. H. Allen.

Friday, January 13th.—At 8 p.m. Institution of Civil Engineers (Students). "Theory of Electricity and Magnetism," by Mr. James Swinburne.

At 7.30 p.m. Institution of Electrical Engineers (Students). Mr. A. E. Jepson on "Electric Heating."

THE ELECTRICAL VOLUNTEERS.

We are asked to publish the following orders for next week :—

Monday, January 2nd.—Headquarters closed.
Tuesday, January 3rd.—"B" Company: Recruits' drill, 6 p.m. Technical instruction, 7 p.m. Medical inspection for recruits and Special Service Section, 7 p.m.
Wednesday, January 4th.—Submarine mining class, 6—9 p.m.
Thursday, January 5th.—"C" Company: Recruits' drill, 6 p.m. Technical instruction, 7 p.m.
Friday, January 6th.—"D" Company. Recruits' drill, 6 p.m. Technical instruction, 7 p.m.
Saturday, January 7th.—Week-end class.

J. Gunn, Sergt.-Major.
For O.C.E.E.R.E. (V.)

The Colloidal State.—In a paper read before the Académie des Sciences on November 28th, G. E. Malfitano expressed the opinion that substances in the colloidal state consist of an electrolyte dissociated into ions, and insoluble molecules grouped round those ions.

NOTES.

A Prosperous New Year!—Humanity is wont to be kind and charitable to its dead, and speaks of their failings—if at all—as with a muffled tongue. To-day we feel inclined to extend a similar considerate reticence to the year which, as we write, has all but gone. Not that the year has been unkind to us personally, for the Electrical Review has reached its highest water mark in some respects; but the depression of our national industries, among them prominently the electrical, has been the cause of some anxiety, and as we write there is much distress in the land. The hopes of approaching improvement, however, urge us forward somewhat eagerly to embrace 1905. May all of our readers and friends have "a Bright and Prosperous New Year!"

Conductivity as a Test for Potable Water.—In an article recently published in the *Revue d'Hygiène* (1904, XXVI., 962) A. Guillard refers to the increased electrical conductivity conferred upon natural water by the presence of dissolved salts, which thus becomes the better the longer the rain has remained in contact with the earth. In Paris daily measurements of conductivity in the wells which provide the public supply of water have been instituted, and in his original paper the author gives numerous examples showing how such tests bring to light variations in the hydrographic conditions prevailing.

South African Notes.—*Transvaal Telegraphs.*—Providing there should be no falling off in revenue of the Post and Telegraph Department, the Transvaal Government will consider the advisability of falling into line with the other South African Colonies, by the adoption of a uniform rate. With regard to Rhodesia, that Administration is in favour of the ultimate adoption by Southern Rhodesia, of the South African Union Telegraph rate, but it is not proposed at present to adopt such a tariff, which would entail a loss of revenue considerably in excess of any sum derived from the increased traffic which might be expected.

Greytown (*Natal*).—The electric light plant was taken over by the Greytown Local Board on November 12th, having been previously run by Messrs. Collins, Kessler & Co., 'Maritzburg. At present there are 15 consumers connected, representing 650 8-c.p. lamps, and applications have been received for an additional 600 8-c.p. lamps. The overhead mains are to be extended, and early in the year it will be necessary to duplicate the present plant.

Kroonstad (*O.R.C.*).—The inauguration of the electric lighting of Kroonstad, which has been carried out by Messrs. Hubert, Davies and Spain, of Johannesburg, took place on November 23rd, the Mayor switching on the current in the presence of the Town Councillors.

Pietermaritzburg (*Natal*).—In the estimates for the year 1904-5, the sum of £5,438 is set aside for street lighting, and in connection with the tramway department the capital expenditure is estimated at £24,250, included in which is £10,000 for permanent way, £5,000 for electrical equipment, and £8,000 for rolling stock. The borough electrical engineer, Mr. Skidmore Ashby, who is retiring through failing sight, has been granted a bonus of £700, equivalent to a year's salary, on condition that his services as local consulting electrical engineer shall be available for that time.

Potchefstroom (*Transvaal*).—The Potchefstroom Town Council has decided upon the municipalisation of the electric lighting plant, provided the company will accept the offer of £6,000 for the business as a going concern.

Cape Town (*Cape Colony*).—The sum of £15,000 has recently been granted by the T.C. for the completion of the Dock Road electric light works.

Boksburg (*Transvaal*).—The electric lighting of Boksburg, over which there has been much delay in the acceptance of the contract, is now well in hand, Messrs. E. H. Gellender & Co., electrical engineers, of Germiston, having secured the contract, and it is hoped to have the plant in operation by April next. The plant will have a capacity of 100 kw., and will consist of a Paxman & Marshall boiler, and two Belliss compound engines, with dynamos by the General Electric Co., of England. The system employed will be the three-wire direct current, 500 volts across the outers, the consumers' voltage being 250. There is a probability of 200 consumers, representing 3,500 8-c.p. lamps. Street lighting will be by 12 arc lamps and 30 incandescents. The price per unit is fixed at 1s.

Papers and Lectures.—At the annual conversazione of the Royal College of Science and Royal School of Mines, held at the college in Exhibition Road, South Kensington, on Thursday last week, Dr. W. Watson, F.R.S., delivered a lecture on "Radium and Twentieth Century Alchemy."

A party of mining students attending the courses in electrical engineering at the Technical Department, University College, Sheffield, were recently, by permission of Mr. Yerbury, chief electrical engineer, shown over the power station of the Corporation tramway department.

Fatality.—On December 27th an inquest was held at Marylebone into the death of Charles Andrews, an employé of the Westminster Electric Supply Corporation, which occurred on Sunday. Deceased was on a ladder attending to a street arc lamp at the corner of Princes Street, Hanover Square, when a hansom cab struck the ladder, bringing Andrews to the ground. The jury returned a verdict of "Accidental Death."

The Rubber Industry.—Sir John Anderson, the Governor of the Straits Settlements, states in his report for 1903, that the cultivation of rubber (Para and Ficus elastica) increases very fast, chiefly in the Native States, but also in Province Wellesley and the Dindings, while small plantations are springing up round Singapore. There has been no great increase in Malacca, despite a suitable soil. Not only Europeans planters, but Malays are beginning to take the cultivation. The growth of the Para trees, especially, leaves nothing to be desired, no disease having appeared and high prices being obtained. On the other hand, the Castilloa as well as the Funtumnia elastica, are both too liable to injury from insect pests and are quite unsuitable.

The gutta-percha plantations in Singapore, Penang and Malacca are thriving, the plants growing well and steadily. The heavy adulterations of the product on it arrival at Singapore have considerably interfered with the trade. Sir F. D. Lugard, in his annual report for Northern Nigeria for 1903, states that the exploration of the Gongola river, and the demonstration of its navigability, has thrown open a fertile country, reported to be rich in rubber and gum, which at present are wastefully collected at a much enhanced cost for transport by Hausa traders. The Administrator greatly deplores the neglect of European firms to take advantage of these openings until the rubber supply is killed by wasteful methods. Good rubber districts are also reported from Nassarawa, while the recently opened up province of Bassa is especially rich in rubber.

A report on the rubber industry of the Gold Coast, by Mr. W. H. Johnson, Director of Agriculture, Gold Coast, with a historical note by Sir W. T. Thiselton Dyer, and a report on rubber cultivation in Sierra Leone, by Mr. C. W. Smythe, curator of the botanical stations, Sierra Leone, has been published in the Miscellaneous Series of Colonial Reports.

Temporary Radio-activity.—The *Comptes Rendus*, November 28th, contains a paper by three experimenters on the genesis of temporary radio-activity. Their experiments have led to the following conclusion:—Temporary radio-activity of a body is due to absorption or simple adhesion of an emanation formed during the ionisation of a gas, and is, in fact, the loss by radiation of this emanation. This emanation provokes, in its turn, the ionisation of a gas.

The James Watt Dinner.—The Glasgow James Watt dinner takes place next month, when it is expected that the Duke of Argyll, the Earl of Glasgow, the Marquis of Graham, and Lord Inverclyde will take part.

Appointments Vacant.—Working electrician for the Bridgend U.D.C. (£130); teacher of electrical engineering for the Doncaster School of Science and Art.

The Heibling Alkali Process.—An account of the Heibling process for making caustic soda or potash by electrolysing an aqueous solution of the respective chloride has been published in a recent number of *l'Electrochemie*. The process is distinguished by the fact that metallic silver is employed to hold the chlorine temporarily, the chloride being afterwards split up into metal again by reversing the direction in which the current travels through the cells. Neither diaphragms nor mercury are used in the baths. Numerous electrodes are disposed alternately in each cell; those of one polarity consisting of carbon plates, the others being perforated lead blocks heavily coated with silver in a porous condition. The liquid is a 1·15 or 1·17 solution of sodium chloride, and the current employed has a mean voltage of 2·25. The operation takes place in two stages. In the first, the carbon plates are connected with the negative, and the "silverised" plates with the positive pole of the dynamo. The salt is then decomposed into caustic soda, the chlorine passing to the silverised electrodes and converting the metal into silver chloride. The hydrogen passes off and is collected in holders. When the decomposition is complete, the vessels are emptied of their contents, and charged afresh with salt solution. The second stage then follows, the current being passed through the cells in a direction opposite to that of the first stage. Nascent hydrogen is produced which decomposes the silver chloride, hydrochloric acid being formed which is then electrolysed. The chlorine is set free, and the hydrogen reduces more silver chloride till all is destroyed. During this stage, the sodium chloride remains unchanged. When evolution of chlorine has ceased, the direction of the current is once again changed, and the first stage of the process is repeated. The hydrogen is used as a source of heat for concentrating the liquors; the chlorine is to be employed for a purpose which is not yet divulged. The advantages claimed for the process are that the chlorine does not come into contact with the caustic alkali, but is liberated from a chloride solution, so that no hypochlorites are produced, and that the losses due to a diaphragm are avoided. The saving in energy is small, for the total voltage required is 4·5 as against the 5 generally necessary. On the other hand, there is a certain amount of capital locked up in the form of silver, and there is an apparent possibility that losses of this metal may occur amongst the products. This point, however, has been investigated by a chemist at Bordeaux, who has found that the liquids are absolutely free from silver. Silver chloride is somewhat soluble in sodium chloride solution; but the first effect of the current would be to decompose any dissolved silver compound, depositing the metal upon the negative electrode. In other respects the caustic is found to be of good quality, analyses showing a liquor of the specific gravity 1·54 to contain 770 grammes of caustic soda per litre and 10·8 grammes, or 1·4 per cent., of common salt.

St. Catherine's Electric Lighthouse.—The *Times* reports that St. Catherine's Lighthouse, situated on the south coast of the Isle of Wight, has just been provided with the most powerful flash-light in this country. The new light is immensely more powerful than the old light, being of 15,000,000 C.P., as against 3,000,000 only with the old apparatus. The light from the new lens, without the upper sections in position, was exhibited on November 29th, it not being possible to fix the upper sections until the temporary apparatus was dismantled. This was accomplished on December 10th, and the full power of the complete lens was exhibited on that night. The new lens is a fine piece of work by Messrs. Chance Bros., Birmingham, the whole of the revolving part floating in a trough of mercury, instead of being on rollers, which has hitherto been usual, about 816 lb. of mercury being required to float it. The lens is rotated by a large clock driven by lead weights working in a solid-drawn steel tube placed in the service-room below. The new subsidiary red light, showing in the direction of the Needles, is worked by reflection, a holophote being placed in the focal plane of the electric arc, and the light projected on to a set of glass prisms; the rays are then bent down, as it were, and thrown on to another similar set of prisms about 20 ft. below, and bent again in a horizontal direction through a ruby plate-glass screen placed in a frame immediately in front of the lower set of prisms. A very powerful red fixed light is thus shown down Channel through an opening which has been cut in the solid masonry of the lighthouse tower. "There is no alteration in the machinery in the engine room. The electric current is generated by De Meritens magneto-electric machines running at 600 r.p.m., and driven by Robey compound steam engines of 50 I.H.P. There are duplicate sets in case of a breakdown. It is interesting to note that, although the machinery has been in use for 17 years, there has never been a breakdown."

Electrical Association of New South Wales.—The thirteenth annual meeting of this association was held at Sydney in November, the president (Mr. O. Haes) being in the chair. The annual report, which was adopted, stated, *inter alia*, that during the year seven papers had been read. The members now number 91, of which two are honorary members, four associates, and 10 students. The election of officers for the ensuing year resulted as follows:—President, Mr. Oswald Haes; vice-presidents, Mr. T. Rooke and Prof. J. A. Pollock; hon. secretary, Mr. E. F. Moates; hon. treasurer, Mr. G. R. Hodson; council, Messrs. E. G. Fleming, A. C. F. Webb, E. Noyes, A. J. Arnot, and T. F. Strickland; auditors, Messrs. A. E. Kaleski and R. J. N. Franki. A paper on "Underground Systems of Electrical Distribution" was read by Mr. J. E. Dodds, and a general discussion took place.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*]

Central Station Engineers.—The Electricity Committee of the Worcester City Council had before it 95 applications for the position of electrical engineer (vacant by the resignation of Mr. C. J. SUTHERLAND) and six were selected to be interviewed.

A presentation was recently made to Mr. J. J. LIGHTFOOT by the staff of the electricity department of the Woolwich Borough Council, prior to obtaining his present appointment with the County of London Electric Supply Co., Ltd. The present took the form of a gold Albert.

Mr. D. M. MACLEOD, assistant engineer to the Poplar undertaking, is to be granted 10 guineas for extra services rendered during the period the post of borough electrical engineer was vacant.

The Leigh Corporation Tramways and Electricity Committee has selected Mr. A. T. SMITH, of Bury, from 147 applicants, for the position of electrical engineer at £250. Mr. D. M. Kinghorn, the present chief at Leigh, is retiring to take up the post of electrical engineer of Southwark at £350.

Tramway Officials.—Mr. JAMES DALRYMPLE, tramway manager of Glasgow, made his first public appearance since his appointment to the position in Springburn Public Hall on the 16th inst., when he delivered a lecture on "The Glasgow Tramways."

General.—Mr. E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E., has been appointed to take charge of the electrical engineering department at Sydney University. Mr. Kilburn Scott's long and varied engineering training gives him an exceptionally clear view of electrical developments. He was one of the first to advocate electric driving in workshops and factories, and alternating-current traction. He has also done good work in criticising fearlessly the unmechanical constructional details which characterised so much of the early electrical work in this country. Of recent years, Mr. Kilburn Scott has been advising on the details of the Bath tramways power house and the power transmission, and three-phase equipment of railways being built by the North Wales Power and Traction Co. He has also advised and drafted specifications, &c., for the Sunderland and District Tramways. For the past five years he has been lecturer to the senior electrical engineering students at the Northampton Institute, Clerkenwell.

We are asked to state that Mr. A. J. LAWSON, M.Inst.C.E., having tendered his resignation in September last as chief electrical engineer to the British Electric Traction Co., Ltd., and its associated undertakings, which he has held for the past three years, severs his connection therewith at the end of the present year. He will continue to practice as a consulting engineer at his present address, 4, Adelphi Terrace, Strand, London, W.C.

The election is announced of Mr. PHILIP WATTS, F.R.S., Director of Naval Construction as a Vice-President of the Junior Institution of Engineers.

Mr. E. GARSIDE has resigned his position of designer and works manager with Messrs. Lionel Robinson & Co., Ltd., and has arranged to join the board of Engineering Instruments, Ltd., as managing director.

NEW COMPANIES REGISTERED.

Shropshire, Worcestershire and Staffordshire Syndicate, Ltd. (82,906).—This company was registered on December 16th, with a capital of £10,000 in £10 shares, to carry on the business of producers, suppliers, buyers, sellers and users of electrical energy for all purposes, engineers, metal and wood workers, agents, railway and tramway proprietors, contractors, &c. The first subscribers (each with one share) are:—W. Eacott, 29, Powell Road, Clapton, N.E., gentleman; T. H. Fidgeon, Sefton Cottage, Forty Hill, Enfield, insurance agent; P. R. Reeves, 8, Bathurst Gardens, Kensal Rise, N.W., shorthand writer; C. T. Lissenden, 24, Arica Road, Brockley, S.E., gentleman; W. J. McNelly, 15, Walter Street, Stepney, E., clerk; A. W. N. Stuart, 31, Careysfoot Road, Clissold Park, N., accountant; and T. J. Bowles, 118, South Esk Road, Forest Gate, E., gentleman. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, 10 shares; remuneration as fixed by the company. Registered office, 53, Victoria Street, Westminster.

Dorchester and District Electric Supply Co., Ltd. (82,854).—This company was registered on December 13th, with a capital of £1,000 in £1 shares, to construct, lay down, establish and maintain cables, wires, lines, accumulators, lamps and works, and to carry on the business of electricians, electrical and general engineers, suppliers of electric light and power, tramway proprietors, &c., in Dorchester or elsewhere. The first subscribers (each with one share) are:—A. West, St. John's Park, Ryde, electrical engineer; H. L. Van Trump, East Street, Taunton, manufacturer; J. H. Waddon, Northfield House, Bridgewater, J.P.; W. L. Machell, 50, Jermyn Street, S.W., gentleman; F. Walker, 2, Portland Villas, Wembdon Road, Bridgwater, electrical engineer; W. T. Pressland, 6, Walsingham Road, Hove, electrical engineer; and T. Hucklebridge, 7, Grange Road, Gunnersbury, surveyor. No initial public issue. The subscribers are to appoint the first directors. Registered office, 11, Carteret Street, Queen Anne's Gate, Westminster.

Kramos, Ltd. (82,859).—This company was registered on December 13th, with a capital of £4,000 in £1 shares, to acquire the business of the Bath Electric Manufacturing Co., Ltd., to adopt an agreement with H. von Kramer, and to carry on the business of ironfounders, mechanical and electrical engineers, manufacturers of and dealers in motors and other engines, whether propelled by electricity, oil, petrol, gas, steam, or other mechanical power, &c. The first subscribers (each with one share) are:—H. von Kramer, 41, New Bridge Hill, Bath, engineer; J. H. Brown, 114, Newbridge Road, Bath, electrical engineer; J. Wolff, 66, Newbridge Road, Bath, electrical engineer; M. Wolff, 66, New Bridge Road, Bath, engineer; Mrs. B. R. von Kramer, 41, Newbridge Hill, Bath; Miss G. C. Simons, 41, Newbridge Hill, Bath; and S. Parkhill, 7, Union Road, Stoke Newington, clerk. No initial public issue. Table "A" mainly applies. Registered office, Locksbridge Engineering Works, Weston, Bath.

Tramways Development Co., Ltd. (82,953).—This company was registered on December 20th, with a capital of £100 in £1 shares, to own tramways, railways, omnibuses and vans, and to equip, maintain and work the same by electrical, steam, horse or other power, &c. The first subscribers (each with one share) are:—J. W. Hain, Broad Street, Avenue, E.C., secretary; H. J. Turner, Ranelagh Cottage, Chiswick, W., clerk; C. D. Lupson, 272, Upland Road, Dulwich, S.E., registrar; J. A. Roney, 33, Cornhill, E.C., secretary; C. G. West, 136, New Cross Road, S.E., clerk; H. T. Holmes, 166, Wilmot Street, Bethnal Green, E., book-keeper; and H. L. Bankes, 33, Cornhill, E.C., clerk. No initial public issue. Registered without articles of association.

New British Electric Supply Co., Ltd. (82,971).—This company was registered on December 21st, with a capital of £2,000 in £1 shares, to acquire the business of electrical manufacturers recently carried on by the New British Engineering Co., Ltd., to adopt an agreement with Bergtheil and Young, and to carry on the business of electrical and mechanical engineers, suppliers of electricity, manufacturers of and dealers in all kinds of electric, magnetic, galvanic, chemical and other appliances, &c. The first subscribers (each with one share) are:—C. E. W. Ogilvie, 30, Budge Row, E.C., solicitor; A. J. Nightingale, 2, William Street, White Hart Lane, Tottenham, clerk; E. L. Parsons, 13, Fox Court, Holborn, E.C., clerk; S. Petts, "Seawfell," Cloverly Road, Hornsey, N., clerk; J. Scrivener, 89, Church Lane, Charlton, engineer; E. D. Flanagan, 91, Glengall Road, Kilburn, N.W., clerk; and A. W. Stourbridge, 16, Latimer Avenue, East Ham, engineer. No initial public issue. The number of directors is not to be less than three nor more than five: the first are A. Bergtheil, H. W. Young and E. Bergtheil; qualification, £100; remuneration as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Chamberlains, Ltd., gas and electric light specialists, London (81,744).—Issue on December 2nd of £60 5 per cent. debentures, part of series created October 6th, 1904, to secure £300, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series: £60.

Bath Electric Tramways, Ltd. (74,278).—Memorandum satisfaction in full of a mortgage dated July 1st, 1904, securing £10,000, and of a mortgage dated October 19th, 1903, securing £92,500, have been filed.

Moelline Co., Ltd., Engineers, &c., London (76,689).—Issue on November 30th of £250 debentures, part of series created March 29th, 1904, to secure £15,000, charged on patents relating to "Moelline," the company's uncalled capital, if any, and its undertaking and general assets, present and future. Holders: City of London Contract Corporation, 3, Tokenhouse Buildings, E.C. No trustees. Previously issued of same series: £12,750.

Fuller, Macleod & Co., Ltd., Electrical Engineers, London (70,197).—A debenture dated December 13th, 1904, to secure £100, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holder: J. A. Ekrenfest, 63, St. John Street, Clerkenwell, E.C. No trustees.

Liverpool Electric Cable Co., Ltd. (71,099).—A debenture dated December 9th, 1904, to secure such sum (not exceeding £6,000) as may be for the time being, owing to the holders in respect of any liability other than that for ordinary monthly trading account, has been registered. Property charged: The company's undertaking and property, present and future, including uncalled capital. Holders: Liverpool Rubber Co., Ltd., 292, Vauxhall Road, Liverpool,

Frinton-on-Sea and District Electric Light and Power Co., Ltd. (70,869).—Issue on December 8th of £500 5 per cent. debentures, part of series created May 7th, 1903, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holders: W. Webster and Miss A. A. Mackay, 50, Lee Park, Blackheath. No trustees. Previously issued of same series: £2,500.

Ernest Scott & Mountain, Ltd., electrical and general engineers, Newcastle-on-Tyne (32,760).—A trust deed dated November 28th, 1904, to secure £50,000 debenture stock, has been registered. Property charged: Certain lands in Coulthards Lane, Gateshead, and the company's other assets, present and future, including uncalled capital. Trustees: W. Scott and N. C. Cookson, of Newcastle-on-Tyne, and J. T. Middleton, The Grange, Ealing.

Scottish House-to-House Electricity Co., Ltd. (29,232).—A charge on the company's undertaking and property, present and future, including uncalled capital, dated December 15th, 1904, to secure £750, has been registered. Holders: County of London Electric Supply Co., Ltd., Moorgate Court, E.C.

Liverpool Electric Cable Co., Ltd. (71,099).—A memorandum of satisfaction in full of a mortgage dated July 29th, 1902, securing not more than £8,000, has been filed.

Charing Cross and City Electric Co., Ltd. (66,081).—A trust deed dated December 13th, 1904, to secure £300,000 debenture stock, uthorised by resolution of December 31st, 1902, have been registered. Property charged: The company's undertaking and property, present and future, including uncalled capital (if any). Trustees: R. J. Gatti, 436, Strand, W.C., and E. E. Johnson, 110, Cannon Street, E.C.

Pacific and European Telegraph Co., Ltd. (36,683 C.)—This company's annual return was filed on December 14th, 1904, when all the shares had been taken up out of a nominal capital of £100,000 in 10,000 shares of £10 each. £4 per share has been called up and £40,000 has been received. Mortgages and charges: £100,000.

Bath Electric Tramways, Ltd. (74,278).—A trust deed dated December 6th, 1904, securing £135,000 debenture stock, has been registered. Property charged—(Specifically): The company's tramway undertaking, including certain land, buildings and plant (as a floating security); the company's assets, present and future, other than uncalled capital and specifically mortgaged premises. Trustees: Sir F. L. Robinson, 10, Observatory Gardens, Campden Hill, London; and H. P. Sturgis, Givons, Leatherhead.

Electric Law Press, Ltd. (London) (72,435).—Issue on December 8th of £200 7 per cent. debentures, part of series created by resolutions of June 23rd and September 30th, 1903, to secure £500, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series: £240.

ELECTRICITY SUPPLY ACCOUNTS.

Farnworth U.D.C. Municipal Electricity Supply and Tramways.

Although of strictly modest proportions, Farnworth can claim for its electrical undertaking a unique record. Even though situated in a manufacturing and coal-producing district, its working costs at under a 1d. per unit., for some 600,000 units output, are excellent. The details of the units supplied indicate the exceptional conditions which exist, and under which the traction and power supplies amount to 80 per cent. of the total output.

Turning to the revenue, it will be noted that the electrical department sacrifices itself on behalf of the sister undertaking, to the extent of supplying it with energy at ¼d. per unit, an exceptionally low figure, in fact, by far the lowest in the country for a traction supply. Under the circumstances the net profit of £32, after meeting financial charges, is well earned.

The prices charged are:—Private lighting, 7d. and 3d. per unit, maximum demand, or 5d. flat rate; power, 2½d. to 1d. per unit; traction, ½d. per unit; and public arcs, £16 per annum.

The tramways undertaking is limited in scope, and its revenue at 7½d. per car-mile is not a good omen, financially. Still, including the low power costs, the working expenses at under 5d. per car-mile are creditably low, and to the considerable financial charge (including a heavy rental) must be attributed the deficiency on the year's working.

Mr. J. D. Pember was the engineer and manager of the above undertakings during the period under review.

General Statement for Year ending March 31st, 1904.

Total capital expended	£36,064
No. of units sold:—	
Private lighting	62,650
Power	191,255
Public lighting	49,794
Tramways, traction	317,126
Tramways, sundry	7,207
Total number of units sold	628,032
Equivalent number of 8-c.p. lamps connected	18,345
H.P. of motors connected	389

Revenue Account.

Gross revenue	£3,796 =	1·45d. per unit
Works, distribution and management costs	£2,196 =	·84d. "
Motor hiring and street lighting expenses	£290 =	·11d. "
Total working expenses	£2,486 =	·95d. "
Gross profit	£1,310	

Average price obtained per unit for private supply	2·04d.
" " " traction	·5d.
" " " public lighting	3·50d.

Profit Statement.

Interest on loans	£756
Sinking fund	522
Balance on year's working	32
Gross profit	£1,310

Tramway Accounts.

Miles of route open	4·3
Miles of track open	7·2
Car-miles run	242,524
Passengers carried	9,532,293
Capital expenditure to date	£43,695
Traffic receipts	£7,486
Total receipts	£7,633
Working expenses	£4,997
Gross profit	£2,636
Income per car-mile	7·55d.
Working expenses per car-mile	4·93d.
Interest, sinking fund and rental charges per car-mile	4·37d.
Profit or loss per car-mile	−1·76d.
Cost of energy per car-mile	·65d.
Average receipt per passenger	1·17d.
Revenue per mile of route	£1,775
Expenditure per mile of route	£1,162
Total number of units used	317,126
Units used per car-mile	1·30
Percentage working expenses to receipts	65 per cent.

Profit Statement.

Interest on loans	£1,841
Sinking fund	1,175
Rent of Kearsley track	1,400
Deficit on year's working	−1,780
Gross profit	£2,636

CITY NOTES.

Blackpool Electric Tramways (South), Ltd.

A special meeting of the debenture-holders was held at Liverpool last week, Mr. J. S. Harmood Banner, as senior trustee, presiding. The *Financial Times* reports that representatives of about £85,000 debenture stock were present. The meeting was called to consider a scheme for writing off 20 per cent. of the debenture stock and asking sanction to pay 3½ per cent. interest on the stock instead of 5 per cent. on the balance for the next 11 years; at the end of that period, if the company achieved the success anticipated, the sum written off the debentures was to be reinstated, and the difference between 3½ per cent. and 5 per cent. paid on the whole stock. He explained that the course he had taken was in the interest of the debenture-holders, and said that, as one of the trustees, he paid over the debenture-holders' money only when he received the engineer's certificate that the line was satisfactory.

After a long and somewhat animated discussion, Messrs. Percy Musgrave (Bolton), A. M. Sing (Liverpool), and Joseph Wilson (Liverpool) were appointed to associate with the trustees (Mr. Harmood Banner and Alderman Joseph Heap) as a committee "to consult as to the best course to be taken in the interest of the stockholders." This committee was empowered to raise £10,000 to meet the immediate requirements of the company, to meet the expenditure necessary in obtaining Parliamentary powers for running into Blackpool to finish the construction of the tramway, and to appoint managers of the undertaking. Thereupon the consideration of the financial scheme was postponed.

Provincial Tramways Co.

The meeting of this company, held last week at 74, Cheapside, E.C., was presided over by Mr. Andrew Beattie, who said that for the half-year ended September 30th last the net revenue from the local companies had been £24,095, against £23,354 in the previous year. Out of this sum the directors proposed a dividend of 3s. per share on the ordinary shares, making 6s. per share for the year, carrying forward £3,496. This result showed a good improvement over the previous year, despite the badness of trade. They had made good provision for depreciation in anticipation of the time when certain of their leases should expire, and felt it wise to have "a good nest egg" for the shareholders at the end of those leases. The board felt that it would be as well to consider the reconstitution of the capital of the company by writing down the £10 shares to £5 each; they would thus get 6 per cent. dividend upon their shares of £5, instead of only 3 per cent., as at the present time, on the £10 shares. The report was adopted. A resolution was carried authorising the company to supply electric energy for power and lighting in the districts of Gosport and Alverstoke.

Manx Electric Railway Co.

The report for the year ended September 30th, 1904, to be submitted at the meeting on the 3rd prox., states that gross receipts amounted to £30,818, and expenditure to £17,279, leaving a net profit of £13,538. To this must be added balance brought forward from last year, £3,266. After paying the preference share dividend there remains to be carried forward £780. During the year a large amount has been spent out of revenue in raising and ballasting the Douglas and Laxey track and also the Snaefell Mountain track, and the whole line has been kept in a good state of repair. Upon capital account there has been expended during the year £20,414 in the completion of the new generating plant and equipment, on rolling stock, the erection of car-sheds, goods sheds and other works. The sum of £1,000 has in addition been set aside out of revenue towards a renewal fund.

British Electric Traction Co.

The interim report states that the directors have not undertaken new obligations of any magnitude, and the policy of restricting capital commitments as much as possible for the present has enabled them to reduce considerably the administration expenses, whilst some promising schemes are kept in reserve to be dealt with when conditions are more favourable. There has been an increase in the aggregate traffic receipts of the associated companies, although, owing to the general depression in trade which has prevailed during the year, the increase has not been so large as was anticipated. It is hoped, however, that, with the expected revival in trade, there will be a further improvement in traffic receipts and in the income from the company's investments, which last year yielded £136,238. The award of the umpire in the matter of the sale of the undertaking of the Poole and District Electric Traction Co., Ltd., to the Bournemouth Corporation has not yet been made, but may be expected shortly. The directors have declared the usual interim dividend at the rate of 6 per cent. per annum upon the ordinary shares for the six months to September 30th last.

Stock Exchange Notice.—The Committee has appointed Thursday, January 12th, 1905, as a special settling day in Henley's (W. T.) Telegraph Works Co., Ltd.—Further issue of 5,000 4½ per cent. cumulative preference shares of £5 each, fully paid, Nos. 35,001 to 40,000, and has ordered the same to be officially quoted.

Raworth's Traction Patents, Ltd.—We are informed that letters of allotment were posted on Friday, the 23rd inst. The company commences business with orders for 65 cars.

Bath Electric Tramways, Ltd.—The directors have declared a dividend at the rate of 5 per cent. per annum upon the 5 per cent. cumulative preference shares of this company, calculated from the due dates of the various instalments to December 31st, 1903. This dividend will be paid, less income-tax, on the 29th inst.

STOCKS AND SHARES.

Wednesday Evening.

Pronounced lassitude, such as usually succeeds the Christmas holidays, is the principal Stock Exchange feature this week. The last few days of the year hold out few temptations to investor or speculator, and we must await the formal opening of the New Year for anything like a return of activity. Prices are extremely hard, and the outlook is distinctly promising.

Meanwhile, it is useful to glance over the net results of 1904, and we take our regular short tables to point a more succinct moral than columns of "copy" could provide. This year the great feature in electrical departments has been the recovery in Telegraph issues, a movement that represents the inevitable swing of the pendulum after the market's flatness induced by previous wireless scares. The figures shall speak for themselves:—

Stock or share.	Dec. 31, 1903.	Now.	Rise.
Anglo Preferred	93	103½	10½
,, Deferred	8	12¼	4¼
Cuba Submarine Ordinary	7⅛	9	1⅞
Direct U.S.	10⅝	10⅞	⅜
Eastern Extension	11¼	13½	2¼
Eastern Telegraph	123⅜	136½	13
Great Northern	25⅝	29	3⅜
Indo-European	38½	45½	7
Western Telegraph	12	13½	1½
National Telephone Pref.	102	108½	6½
,, ,, Def.	78½	101½	23

Much of the greater part of the improvement has been scored in the last half of the year, and it may be observed that at the end of June, Anglo "A" stood at about half its present quotation. But more sensational has been the jump in National Telephone Deferred stock, where the rise amounts to no less than 23 points, 15 of which accrued since the beginning of July. West India and Panama first Preference have advanced 30s. to their current level of 7½. Reuter's show a rise of 5s. on the year.

The London Traffic Commission put a check upon new "Tube" schemes during 1904, but there are several interesting changes to notice in existing stocks. Here are some of them:—

Stock.	Dec. 31, 1903.	Now.	Rise or fall.
Central London Ordinary	94½	91	3½
,, ,, Preferred	100½	102	1½
,, ,, Deferred	94½	85	9½
City & South London	48⅝	46	2⅝
Waterloo and City	92½	89	3½
Metropolitan Consolidated	86	96	10
Metropolitan District	34	40	6

In the above brief statement stands reflected a 12 months' verdict upon the possible loss which electrification of the two Undergrounds may entail upon the Central London. The verdict, of course, is open to radical change, but for the moment, thus it stands. City and South London fell by reason of the fierce competition, to which it is now exposed, and Waterloo and City's decline is mainly traceable to the glut of excellent 3 per cent. investments that have been so plentifully offered to the public this year.

Electricity Supply shares have no particular feature to offer as resulting from the 12 months' work. In the representative list here set out, there are six rises against a trio of falls, but the movements of both directions are void of any special sensation, with the single exception of that in Metropolitan. All the good companies that have required new capital, got it with ease, principally from their own shareholders. This is our list:—

Shares.	Dec. 31, 1903.	Now.	Rise or fall.
Brompton and Kensington	10½	10⅜	⅛
Charing Cross	9	8½	½
City of London	10¾	11	¼
County of London	8	9½	1½
Edmundson's	6¼	6¼	—
Kensington and Knightsbridge	11	12⅜	1⅜
Metropolitan	17½	17	½
Notting Hill	13	14⅜	1⅜
St. James's	15	14	1
Urban	5	5	—
Westminster	12½	13	½

Considering the bad time for Stock Exchange values that 1904 has proved, the electrical supply section cannot complain of undue neglect. Metropolitan Ordinary, though apparently 10s. lower, are really £5 10s. up, because proprietors received £6 per share return of capital in the early part of the autumn.

British Electric Tractions began the year at 11½ and finish it at their par price of 10. London United Preference at 10¾ have lost 10s., but the Debenture is a point firmer at 104. The British Colombia stocks excited a deal of interest in the first six months, the Deferred rising 21½, an improvement that has been exactly maintained up till now. The Preferred at 101½ gained 9 per cent. Visible activity on the part of the Metropolitan Electric Tramways Co. has pushed up the shares from 5s. to 8s. 3d., and the Debenture stock is up to 105. At 8¼, Calcutta Tramways are 25s. better. The Anglo-Argentine Tramway issue of Ordinary shares at £5 10s. was left in great part to the underwriters; these latter can take a comfortable profit of £2 5s. per share to-day.

For manufacturing and kindred undertakings, the year, as a whole, has not been a happy one. Nevertheless, Telegraph Construction shares sympathised with the firmness of the telegraph market, as the appended statement shows, and Edison & Swan have a much healthier appearance.

Stock or share.	Dec. 31, 1903.	Now.	Rise or fall.
British Insulated	6½	5½	1
British Westinghouse Pref.	4½	2½	2
Callender's	11¼	9½	1¾
Electric Construction	1½	1 5/16	1/16
Edison & Swan	⅝	¾	⅛
Henley's	14	10½	3½
India-Rubber	18½	15½	3
Telegraph Construction	95½	89	6½

India-Rubber and Westinghouse Preference shares stand out with unenviable prominence, but there has also been a sharp drop in Henley's and another, of half the amount, in Callender's. A ⅛ advance leaves Babcock & Wilcox shares at 3 3/16, Willans and Robinson, however, are no better than 30s. Despite the mixed nature of the fluctuations in all electrical prices, as shown in the foregoing tables, it is noticeable that rises are more in evidence than falls, and provided 1905 brings some of the business expected from it, this tendency should be far more marked at the conclusion of what we are now calling the New Year.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations Dec. 21st.	Closing Quotations Dec. 28th.	Business done week ended Dec. 28th, 1904. Highest	Lowest
87,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	100 —103	100 —103	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	1 — 1⅛	1 — 1⅛	..	..
119,700‡	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	.. — ..	.. — ..	..	..
788,840	Anglo-American Telegraph	Stock	61s.	60/6	61s.	55 — 57	56 — 58	58⅜	..
5,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	103 — 104	103½ — 104½	103⅞	103
5,105,580	Do. do. do. Deferred	Stock	2s.	1/-	2s.	12⅛ — 12⅜	12⅛ — 12½	12 1/16	12
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	7 %	5¾ — 6	5¾ — 6	..	..
18,888,800$	Commercial Cable	$100	8 %	8 %	..	170 —190	170 —190	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	93 — 96	93 — 96	..	..
16,000	Cuba Telegraph	10	4 %	6½%	5 %	8⅞ — 9¼	8⅞ — 9¼	..	..
6,000	Do. 10 % Pref.	10	..	..	..	16¼ — 17½	16¼ — 17½	..	..
12,981	Direct Spanish Telegraph, Ord.	5	..	..	..	3⅜ — 3⅝	3⅜ — 3⅝	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7¼ — 8¼	7¼ — 8¼	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	102 —104	102 —104	..	..
60,710‡	Direct United States Cable	20	8½%	8½%	9 %	10⅜ — 11	10⅜ — 11	..	..
81,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,900, Red.	100	..	..	..	101 —103	101 —103	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	135 —138	135 —138	136⅜	135
1,955,555	Do. 8½ % Pref. Stock	100	..	..	..	89 — 90	88 — 90	89⅛	88½
1,584,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —107	105 —107	105	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	13¼ — 14	13¼ — 14	13⅝	13⅜
820,000‡	Do. 4 % Deb. Stock	Stock	..	..	..	106 —108	106 —108	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	101 —103	101 —103	..	..
200,000‡	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	100 —102	100 —102	..	..
180,227	Globe Telegraph and Trust	10	5½%	£3 16 7*	5½%	10¼ — 10½	10¼ — 10½	10½	10¼
180,042	Do. do. 6 % Pref.	10	..	..	..	14 — 14½	14 — 14½	14	..
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	15 %	28⅜ — 29½	28⅜ — 29½	29 1/16	..
54,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,900, Red.	100	..	..	..	101 —103	101 —103	..	..
17,000	Indo-European Telegraph	25	10 %	10%	10 %	44½ — 46½	44½ — 46½	..	..
72,680	Monte Video Telephone Co., Ltd., Ord.	1	2½%	3 %	3 %	3/- — 3/3	3/- — 3/3	..	..
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	108½ —109½	108 —109	109	107½
1,966,667	Do. do. Def. Stock	100	..	4½%	5 %	101 —104	101 —102	100	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 13	12 — 13	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 5/16 — 5 7/16	5 5/16 — 5 7/16	5⅜	5 5/16
000,000‡	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	98 — 99	98 — 99	98	..
689,593	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	104½ —105½	103½ —104½	..	..
1,000,000	Do. do. Prov. Certs., 85 % to be paid	..	..	..	..	67½ — 68½	67½ — 68½	..	..
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6½%	1 — 1⅛	1 — 1⅛	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1⅛ — 1¼	1⅛ — 1¼	..	..
100,000‡	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	98 —100	94 —100	..	..
11,889	Reuter's	8	5 %	5 %	..	7 — 7⅛	7 — 7⅛	..	..
5,808	Submarine Cables Trust	Certs.	..	..	..	120 —123	120 —123	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	6⅜ — 6⅞	6⅜ — 6⅞	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
179,947‡	Do. do. 5 % Debs.	Stock	..	..	..	105½ —107¼	106 —108	107½	..
15,809	West African Telegraph, Shares	10	..	2 %	4 %	7⅛ — 7⅜	7⅛ — 7⅜	..	..
30,008	West Coast of America, 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	⅞ — 1	⅞ — 1	..	..
150,000‡	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	98 —100	98 —100	99⅜	99⅛
207,280	Western Telegraph, Ltd., Nos. 1 to 207,280	10	7 %	7 %	7 %	13¼ — 14 xd	13½ — 14	..	..
75,000‡	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	103 —105	103 —105	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	101¼—102½	102 —104	..	..
88,221	West India and Panama Telegraph	10	..	..	..	⅞ — 1	⅞ — 1	..	..
84,568	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	7⅛ — 7⅝	7⅛ — 7⅝	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	6⅞ — 7¼	6⅞ — 7¼	..	..
60,000‡	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	103½ —105½	103½ —105½	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

90,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	7¾ — 8¼	8⅛ — 9	..	..
10,000	Do. do. "A" 6 % Cum. Pref.	10	..	..	..	⅞ — 9	9 — 9½	..	..
800,000‡	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	96 - 100	98 — 100	..	..
100,000	British Electric Traction	10	9 %	8 %	..	9⅜ — 10¼	9⅜ — 10¼	10	..
100,000	Do. do 6 % Cum. Pref.	10	..	..	..	10⅜ — 11 1/16	10⅜ — 10⅞	11	10⅞
600,000‡	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	117 —119	117 —119	..	..
	Do. do. 4½% 2nd Deb. Stock Red.	100	..	..	..	95 — 97	95 — 97	..	..
100,000	British Insulated and Helsby Cables	5	10 %	10 %	8 %	5¼ — 5⅜	5¼ — 5⅜	5 1/16	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	104 —105	102 —105	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	⅞ — 1 1/16	15/16 — 1 1/16	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	Nil	⅞ — 1	⅞ — 1	⅞	..
150,000	Do. do. Non-cum. 6 % Pref.	2	8 %	6 %	6 %	1⅜ — 1⅝	1⅜ — 1⅝	..	..
125,000‡	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	93 — 96	93 — 96	..	..
125,000‡	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	69 — 73	69 — 73	..	..
85,000	Callender's Cable Construction shares	5	20 %	15 %	12½%	9⅛ — 10	9⅛ — 10	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5 — 5⅛ xd	5 — 5⅛	..	..
90,000‡	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —106	105 —107	106	105½
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	90 — 92	90 — 92	90⅞	90⅛
494,098	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	101 —1 3	101 —103	102	..
494,998	Do. do. Def. do.	Stock	4 %	4 %	4 %	84 — 86	84 — 86	..	..
1,880,000	City and South London Railway	Stock	2 %	3½%	2⅝%	45⅛ — 46½	45⅛ — 4 ⅛	46½	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	7½%	5 %	..	1⅞ — 2	1⅞ — 2	..	..
100,000‡	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	94 — 99	94 — 19	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,261	5	Nil	Nil	..	⅜ — ⅞	⅜ — ⅞	..	..
17,139	Do. do. "A" shares, 01—017,139	5	Nil	Nil	..	1 — 1⅛	1 — 1⅛	..	..
344,023‡	Do. do. 4 % Deb. Stock Red.	100	..	..	..	78 — 83	78 — 83	..	..
100,000‡	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	79 — 84	79 — 84	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	6 %	4 %	1⅛ — 1⅜	1⅛ — 1⅜	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	5	..	..	..	2⅛ — 2⅜	1⅞ — 2⅛	..	..
82,500‡	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	93 —100	93 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9⅛ — 10	9½ — 10	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	91 — 96	91 — 96	..	..
200,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	15 %	10¼ - 10⅜	11⅛ - 10⅛	11⅜	..
200,000	Do. do. 4½ % Pref.	5	..	..	..	⅝ — 5⅜	⅝ - 5⅜	5 1/16	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	110 —112	110 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	15½ — 16½	15 — 16	16⅛	15⅞
800,000‡	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	99 —102	99 —102	..	..
87,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	31 1/16 — 31 3/16	31 1/16 — 31 3/16	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10 — 10⅜	10 — 10⅜	..	..
87,350	Telegraph Construction and Maintenance	12	20 %	20 %	20 %	38 — 40	38 — 40	39	3 ½
150,000‡	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	103 —105	103 —105	..	..
540,000‡	Waterloo & City Railway, Ord. Stock	100	8 %	8½%	8½%	88 — 90	88 — 90	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List

(Bank rate of discount 3 per cent. (April 21st. 1904).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).— ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years 1901.	1902.	1903.	Closing Quotations Dec. 21st.	Closing Quotations Dec. 28th.	Business done week ended Dec. 28th, 1904. Highest.	Lowest
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	£	8%	8 %	10 %	10½ — 11	10½ — 11	..	..
20,000	Do. do. 7 % Cum. Pref. ..	£	..	..	..	10½ — 10¾	10½ — 10¾	..	..
250,000	Central Electric Supply 4 % Guar. Deb. Stock	100	..	..	..	104 —107	104 —107	..	..
50,000	Charing Cross and Strand Electricity Supply	£	10 %	10 %	8 %	8⅞ — 8¾	8⅞ — 8¾	..	..
70,000	Do. do. 4½% Cum. Pref. ..	£	..	..	..	5 5/16 — 5 3/16	5 5/16 — 5 3/16	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	£	..	..	..	4 13/16 — 4 11/16	5 — 4⅞	..	..
40,000	Do. do. 1903	£	..	..	..	4 13/16 — 4 11/16	5 — 4⅞	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	101 —103 xd	101 —103	102⅝	101¾
44,436	*Chelsea Electricity Supply, Ord.	£	4 %	4¾%	5¾%	6⅝ — 6¾	6⅝ — 7	6¾	..
150,000£	Do. do. % Deb. Stock Red.	Stock	..	..	..	109 —111	109 —111	110½	110
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	£	10	5 %	5 %	10⅜ — 11¼	10⅜ — 11¼	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	£	10	..	..	13½ — 14	13½ — 14	..	..
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	£	..	..	..	123 —127	123 —127	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	103 —105	103 —105	104¾	..
40,000	County of London Electric Lighting, Ord. 1—40,000	£	10	4 %	4 %	9 — 9¼	9 — 9¼	9¼	..
90,000	Do. do. do. 6 % Pref., 40,001—60 ..	£	10	..	..	12 — 12½	12 — 12½	12½	..
400,000£	Do. do. 4½% Deb. Stock	£	..	..	..	107 —110	107 —110	..	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	101 —103	101 —103	..	..
70,000	Edmundson's Electric Corporation, Ord. Shares	£	7 %	7 %	7 %	6⅛ — 6⅜	6⅛ — 6⅜	6⅜	..
70,000	Do. do. 6 % Cum. Pref.	£	..	..	..	6 — 6¼	6 — 6¼	6¼	6 3/16
300,000£	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	107 —109	107 —109	108½	108
21,000	Kensington and Knightsbridge Electric Ord.	£	10 %	10 %	12%	12⅛ — 13	12⅛ — 13	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	102 —104	102 —104	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	£	..	..	..	2⅜ — 2⅝	2⅛ — 2⅜	..	..
49,840	Do. do. do. 6 % Pref.	£	..	..	..	5 1/16 — 5 3/16	5 1/16 — 5 3/16	..	..
250,000£	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	95 — 97 xd	95 — 97	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	£	6⅔%	7½%	8⅓%	16⅜ — 17½	16⅜ — 17½	17 3/16	16⅝
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	£	..	..	..	5¼ — 5⅝	5¼ — 5⅝	5⅝	..
290,000£	Do. do. 4½% 1st Mort. Deb. Stock	£	..	..	..	112 —117	112 —117	..	..
250,000£	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	97 — 99	97 — 99	98½	..
10,862	Notting Hill Electric Lighting	£	6 %	6 %	6 %	14½ — 15	14½ — 15	..	..
59,000	Do. do. 4% 1st Mort. Deb.	100	..	..	..	101 —103	101 —103	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	£	14½%	14½%	14½%	13⅞ — 14½	13⅞ — 14½	13 13/16	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	£	..	..	..	8½ — 9	8½ — 9	..	..
150,000£	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	99 —101	99 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	£	..	2½%	4 %	2⅞ — 8½	2⅞ — 8½	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	83 — 87	88 — 87	..	..
65,000	South London Electricity Supply, Ord.	£	..	1¾%	3 %	4¼ — 4⅜	4¼ — 4⅜	..	..
100,000	South Metropolitan Electric Light and Power Ord.	£	..	..	..	1 1/16 — 1 1/8	1 1/16 — 1 1/8	..	..
50,000	(*Late Blackheath and Greenwich Dist. E.L.Co.*) 7 % Pref.	£	..	..	..	1⅜ — 1 7/16	1⅜ — 1 7/16	..	..
100,000	4½% 1st Deb. Stock	100	..	..	..	107 —110	107 —110	..	..
80,000	Urban Electric Supply, Ord.	£	..	..	..	4 13/16 — 5 1/16	4 13/16 — 5 1/16	5 1/16	5 1/16
80,000	Do. do. 5 % Cum. Pref.	£	..	..	..	5 — 5⅛	5 — 5⅛	5⅛	..
200,000	Do. do. 4½% 1st Mort. Deb. Stock Red	100	..	..	..	104 — 106	104 —106	105½	101½
110,000	Westminster Electric Supply, Ord.	£	10⅓%	12 %	13⅓%	12⅝ — 13⅛	13	13	..
28,141	Do. do. 5 % Cum. Pref.	£	..	..	..	6⅛ — 6⅜	6¼ — 6⅜	6½	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, December 28th.

CHEMICALS, &c.

		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric .. .. .. per cwt.		5/-	..
a ,, Nitric .. .. per cwt.		22/-	..
a ,, Oxalic .. .. per cwt.		82/-	..
a ,, Sulphuric .. .. .. per cwt.		5/6	..
a Ammoniac, Sal .. .. .. per cwt.		42/-	..
a Ammonia, Muriate (crystal) .. per ton		£38 10	..
a ,, ,, ... per ton		£30	..
a Bleaching powder .. .. .. per ton		£5 5s	..
a Bisulphide of Carbon .. .. per ton		£15	..
a Borax .. .. per ton		£13	..
a Benzole (90%) .. .. .. per gal.		7/-	..
a ,, (50/90%) .. .. .. per gal.		5/6	..
a Copper Sulphate .. .. .. per ton		£23	..
a Lead, Nitrate .. .. .. per ton		£25	..
a ,, White Sugar .. .. per ton		£31	..
a ,, Peroxide .. .. .. per ton		£37 10	..
a Methylated Spirit .. .. .. per gal.		2/6	..
a Naphtha, Solvent (90% a 160° C). per gal.		5/6	..
a Potash, Bichromate, in casks .. per lb.		8d.	..
a ,, Caustic (75/80%) .. .. per ton		£19	..
a Shellac .. .. per cwt.		200/-	40/- dec.
a Sulphate of Magnesia .. .. per ton		£4 10	..
a Sulphur, Sublimed Flowers .. per ton		£6 10	..
a ,, Recovered .. .. per ton		£5 10	..
a ,, Lump .. .. .. per ton		£5	..
a Soda, Caustic (white 70%) .. per ton		£10 15	..
a ,, Crystals .. .. .. per ton		£8	..
a ,, Bichromate, casks .. .. per lb.		2½d.	..

METALS, &c.

b Aluminium Ingots, in ton lots .. per ton		£180	..
b ,, Wire, in ton lots .. per ton		£168	..
b ,, Sheet, in ton lots .. per ton		£166	..
b Babbitt's metal ingots .. .. per ton		£43 to £140	..
c Brass (rolled metal 2" to 12") basis per lb.		7¼d.	..
c ,, Tube (brazed) .. .. per lb.		9¼d.	..
c ,, ,, (solid drawn) .. .. per lb.		8¾d.	..
c ,, Wire, basis .. .. .. per lb.		7¾d.	..
c Copper Tubes (brazed) .. .. per lb.		10d.	..
c ,, ,, (solid drawn) .. per lb.		10½d.	..
c Copper Bars (best selected .. per ton		£79	..

METALS, &c. (*continued*).

		Latest Price.	Week's Dec. or Inc.
g Copper Sheet .. .. .. per ton		£79	..
g ,, Rod .. .. .. per ton		£79	..
e ,, (Electrolytic) Bars .. per ton		£70 10	..
e ,, Sheets .. per ton		£87	..
e ,, ,, Rod .. per ton		£81	..
e ,, ,, H.C. Wire per lb.		9¼d.	..
f Ebonite Rod .. .. .. per lb.		8/8	..
f ,, Sheet .. .. .. per lb.		8/-	..
n German Silver Wire .. .. per lb.		1/6	..
h Gutta-percha fine .. .. .. per lb.		8/-	..
h India-rubber, Para fine .. .. per lb.		5/2 to 5/3	inc.
i Iron, Charcoal Sheets .. .. per ton		£18	..
i ,, Pig (Cleveland warrants) per ton		51/-	2/7 inc.
i ,, Forgings, according to size per ton		From £11	..
i ,, Scrap, heavy .. .. per ton		47/6 to 50/-	..
i ,, Wire, galvanised No. 8 .. per ton		£9 15	..
g Lead, English Ingot .. .. per ton		£13 2 6	2/6 inc.
g ,, ,, Sheet .. .. per ton		£14 7 6	2/6 inc.
m Manganin Wire No. 28 .. .. per lb.		8/-	..
g Mercury .. .. per bot.		£7 15	..
d Mica (in original cases) small .. per lb.		6d. to 1/	..
d ,, ,, ,, medium per lb.		2/6 to 4/-	..
d ,, ,, ,, large .. per lb.		4/6 to 8/6	..
p Phosphor Bronze, plain castings per lb.		1/0½ to 1/3	..
p ,, ,, rolled bars & rods per lb.		1/0½ to 1/3	..
p ,, ,, strip & sheet per lb.		1/2	..
o Platinum .. .. per oz.		81/6	..
e Silicium Bronze Wire .. .. per lb.		10d. to 11½d.	..
i Steel, Magnet, acc'd'g to desc'p'n per ton		£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block .. .. per ton		£184 to £185	50/- inc.
g ,, Foil .. .. per lb.		1/6	..
n ,, Wire, Nos. 1 to 16 .. .. per lb.		1/8	..
p White Anti-friction Metals— "White Ant" brand .. per ton		£48 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls per lb.		8d.	..
j ,, 6 lea. Flax .. .. .. per lb.		6¾d.	..
j ,, 3 ply 10 lbs. Russian .. per lb.		4 15/16d.	..
j ,, 10 lbs. Russian, single .. per lb.		4¼d.	..
j ,, 160 lbs. Jute rove .. per ton		£11	..
k Zinc, Sh't (Vieille Montagne bnd.) per ton		£29 7 6	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co., *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Week ending	Receipts for the week. £	Receipts for the week. £*	No. wks.	Total to date. £	Total to date. £*	Miles open.	*
Aberdeen	Dec. 24	1,147	— 28	30	42,834	+ 5,687	10	—
Bath	,, 21	564	—	52	32,258	—	12½	—
Birmingham ..	,, 17	5,488	+ 473	51	274,008	+15,009	32	—
Blackburn	,, 9	738	+ 1	36	34,879	+ 3,334	13½	—
Blackpool	,, 22	276	— 4	39	43,175	+ 5,966	8½	—
,, —Fleetw'd	,, 24	182	— 44	25	21,698	+ 344	7½	—
,, —Lytham	,, 15	119	— 21	7	849	—	7½	—
Bolton	,, 18	1,678	+ 68	38	69,973	+ 556	25	—
Bournemouth ..	,, 21	857	— 16	38	42,179	—	10½	—
Bradford	,, 17	3,729	+363	35	169,463	+27,031	54	—
Brighton	,, 18	758	+ 7	37	38,696	—	9	—
Bristol	,, 23	5,076	—189	—	—	—	28	—
Devonport ..	,, 16	447	— 13	50	26,401	+ 3,214	5	—
Dudley—Sto'rb'ge	,, 16	784	+ 6	50	43,154	+ 1,386	18½	—
Gateshead ..	,, 16	857	— 1	50	45,435	+ 1,388	10½	—
Gr'n'k—Pt. Glsgw	,, 16	447	+ 16	50	28,718	+ 1,448	7½	—
Oldham—Ashton	,, 16	484	— 14	50	27,278	— 1,113	8	—
Potteries	,, 16	1,759	+ 90	50	86,026	+ 6,113	28½	—
South Staffs. ..	,, 16	625	—330	50	38,021	— 8,279	21½	—
Swansea	,, 16	459	— 3	50	25,888	+ 911	5½	—
Wolverhampton ..	,, 16	335	+ 12	50	19,399	— 55	10	+8
Yorks. Wool Dist.	,, 16	488	+ 53	50	28,978	+ 8,938	6	—
Miscellaneous ..	,, 16	2,593	—	50	177,118	—	—	—
Burnley	,, 24	982	+ 35	—	—	—	10½	+2½
Burton-on-Trent ..	,, 18	288	+ 6	37½	13,010	—	8½	—
Cardiff	,, 8	1,816	+116	35	72,812	+ 1,653	14	—
Chatham & District	,, 15	502	— 17	50	29,080	+ 2,090	8·53	—
Cork	,, 22	446	— 36	51	23,764	— 2,516	9·29	—
Dover	,, 17	180	+ 11	50	10,791	— 573	8	—
Dublin	Dec. 16	4,404	+ 67	—	122,222	— 2,387	47	—
East Ham	,, 17	618	+ 24	37	27,049	+ 1,509	6½	—
Glasgow	,, 24	14,067	+570	30	426,588	+20,866	72½	+ 3
Halifax (2 weeks) ..	,, 14	2,261	+169	37	55,346	+ 4,070	34½	+ 3
Huddersfield ..	,, 17	1,170	+ 62	37	50,417	+ 3,090	28	—
Hull	,, 24	2,291	— 26	38	84,012	+10,457	13	+2
Ilkeston	,, 21	87	— 33	38	5,294	— 360	3·5	—
Ipswich	,, 24	846	—124	38	18,680	—	10½	+ 4
Isle of Thanet ..	,, 24	260	— 15	51	31,587	+ 1,595	10½	—
Leeds	,, 17	5,411	+454	38	220,508	+12,845	89½	+7½
Liverpool	,, 17	10,121	+868	51	526,698	+14,645	108	—
London C. C. ..	,, 10	11,930	+3022	36	464,618	+100886	47½	+7½
Manchester	,, 24	11,008	—602	38	467,465	+18,779	137½	+12½
Newcastle	,, 17	3,544	+ 28	—	—	—	17	—
Portsmouth	,, 17	1,487	+ 63	38	74,442	+ 5,792	14½	—
Salford	,, 19	3,817	+101	37	153,476	+ 7,978	30	—
Sheffield	,, 18	4,548	+810	39	177,971	+ 3,895	34½	+1½
Southampton ..	,, 22	908	— 69	38	37,739	— 2,424	16½	—
Southend-on-Sea ..	,, 21	237	+ 5	38	14,192	+ 1,418	6½	—
Sunderland	,, 18	1,116	+ 44	37	47 804	+ 1,092	21	+1
Tyneside	,, 21	330	+ 56	51	19,649	+ 3,300	8·9	+ ·4
West Ham	,, 22	1,012	—	43	40,778	—	9·78	—
Wolverhampton ..	,, 14	668	+277	—	—	—	9·5	—
Cen. London Rly. ..	,, 24	7,744	+1332	25	161,109	+ 1,077	6	—
City & S. Lon. Rly.	,, 25	9,767	+788	26	69,065	— 1,628	6½	—
Dublin—Lucan Rly.	,, 23	105	+ 8	25	3,120	+ 1	6½	—
G. N. and City Ry.	,, 17	1,405	—	44	45,907	—	3½	—
L'pool Overh'd Rly.	,, 25	1,495	— 66	26	40,597	— 2,315	6½	+4½
[illegible] Ry'way ..	,, 17	1 648	+ 222	24	35 734	+ 3.244	4½	—

* Compared with the corresponding period of 1903.

INSTITUTION OF ELECTRICAL ENGINEERS.

COMPENSATED ALTERNATE CURRENT GENERATORS.

By Miles Walker, B.A., A.I.E.E.

(*Abstract of Paper read November 29th, 1904, at Manchester.*)

In all large modern power plants the old simple type of field magnet is employed, and the tendency is to call for better and still better inherent regulation. This can only be secured by making the ampere-turns on the field magnet great, relatively to the ampere-turns on the armature, and good regulation in this way can only be secured by increasing the cost of the generator. Roughly speaking, a 6 per cent. regulating generator will cost 1·5 times as much as a 12 per cent. regulating generator of the same output.

If we are to have compensated A.C. generators in the future, they must not only be instantaneous in their operation and run well in parallel, but they must be free from complication and from gear that requires attention. The addition of a commutator will always be regarded as a backward step, unless it can be shown that it is free from sparking, is inexpensive, and permanent in its nature.

Another important requirement is the applicability to steam turbine-driven generators. Most of the large steam-driven A.C. generators in the future will be turbo-generators, and the commutator is not a desirable adjunct to a high speed machine.

Of the various methods of compensating synchronous generators, most operate by changing the exciting current. One method that I will describe in this paper preserves the field excitation constant and utilises the armature field to raise the voltage. It is impossible to change the field current with sufficient rapidity to prevent fluctuation in the voltage when a considerable fraction of the load is thrown on. The advantage of employing the armature field to restore the voltage is that its effect is instantaneous.

Broadly, there are four methods of compensating by altering the field excitation:—

(*a*) By a rectified current supplied to a separate winding. (Simple composite wound generators.)

(*b*) By a rectified current, increasing with decreasing power factor, supplied to the main winding (as in the generators of Heyland and Latour).

(*c*) By operating upon the exciter with the alternating current so as to raise its voltage (as in the methods of Rice and Leblanc).

(*d*) By operating a rheostat automatically. There are numerous methods of doing this, but they do not fall within the compass of this paper.

The simple rectification of alternate current for exciting purposes is well illustrated in the case of the old Westinghouse composite wound generator. This machine has been on the market since the early days of alternators, and is still doing good service on loads of nearly constant power factor.

The current from the armature passes through a series transformer, producing a secondary current which is proportional to the

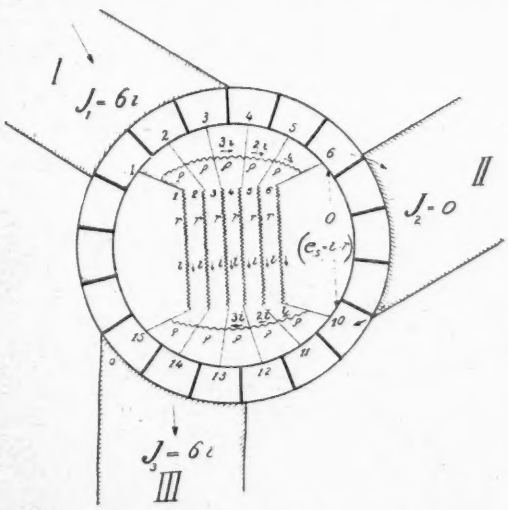


Fig. 1.—Heyland Rectifier.

load. This secondary current passes to a commutator, by which it is converted into a uni-directional current, which goes to an auxiliary field winding, so that, as the load increases, the field becomes stronger.

The short-circuiting of the segments of the commutator during a certain interval enables the commutation to be carried out perfectly, even with copper brushes, and without any shifting of these brushes between no load and full load, provided the power factor remains constant.

The General Electric Co., of America, many years ago adopted a system in which the three ends of a star winding, which would ordinarily be connected to a common junction, are connected to a three-part commutator, which supplies uni-directional current to two brushes in series with the auxiliary winding. Where the number of poles is greater than two, the number of segments of the commutator is proportionally increased. Shunt resistances are used to help out the commutation and enable the amount of compounding to be adjusted.

The electrolytic rectifier has received a great amount of attention of late years, and various experimenters have so increased its efficiency and lasting qualities that there seems some prospect in the future of its competing with the commutator. The Cooper-Hewitt mercury vapour rectifier, too, is coming every day nearer and nearer to perfection.

One of the uses to which these rectifiers can be applied is the compounding of alternate current generators.

We now come to what is certainly the most successful self-exciting compounded A.C. generator upon the market—the generator devised by Alexander Heyland. This machine is excited by a

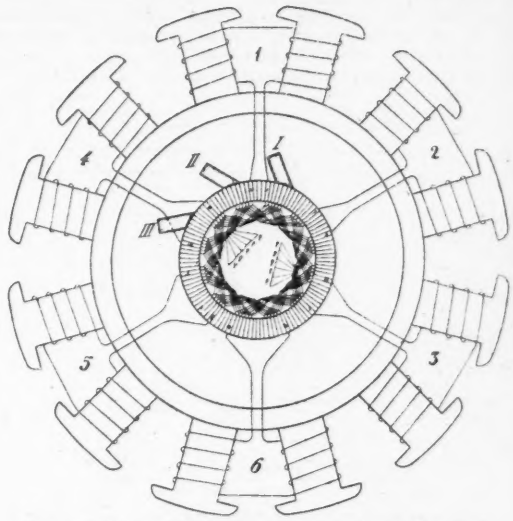


Fig. 2.—Heyland's Connections to Field Magnet.

rectified current, which increases with the load and also as the power factor becomes lower, so as to maintain almost constant voltage for any condition of load. It is provided with a special winding, which greatly facilitates the commutation of the current.

The simplest way of explaining the generator lies in regarding it as being excited by a rectified current through a number of field windings connected in parallel.

Fig. 1, which is taken from Heyland's paper, read before the St. Louis Convention, shows the principle as applied to a two-pole generator. Here six exciting circuits (r) are placed in parallel, being inter-connected by resistances (ρ). The end of each circuit is connected to a commutator bar, as shown, and a three-phase current is fed into the commutator by the three brushes. Consider that at the instant when the commutator brushes are in the position shown the current in the upper brush I is sinking from a maximum, being, in fact, ·866 of the maximum value. The current will divide between the different windings, and go out by brush III. As the commutator rotates clockwise, the current in brush II will gradually increase to its maximum until the instant when the bars Nos. 3, 4 and 5 are opposite it. The current will then be partly fed in by brush I and partly by brush III. As each brush receives its maximum current, it also receives its complement of bars into which to feed it. This is the condition of affairs which would give the six circuits their lowest apparent resistance, but it is obvious that a considerable change may be made between the phase positions of the current and commutator without materially affecting the commutation, because the resistances ρ tend to distribute the current in all the circuits. Note that the current is always passing the same way through the six circuits.

Fig. 2 shows one of the ways of winding the six circuits on a 12-pole machine. The form of the field magnet need not differ in any way from that of simple uncompensated field magnets.

The fact that there are always several paths open for the current, and that the ends of the commutator bars are bridged by resistances, obviates the tendency to spark. The three-phase current is supplied partly by a transformer connected as a shunt across the mains, which supplies a nearly constant current, whose phase is fixed by the voltage of the generator, and partly by a transformer in series with the mains, which supplies currents proportional to and in phase with the armature currents. These currents are combined as shown in fig. 3 the result being that, as the load increases, the resultant three-phase currents increase, and the lower the power factor the greater the increase. In order to adjust the compounding, the machine is run at zero power factor, and adjustable resistances are inserted in the shunt circuit. The number of turns in the series and shunt transformers can be changed so as to give the desired over-compounding either at non-inductive load or at any power factor. I am indebted to Messrs. Witting, Eborall & Co., who supply these generators in this country, for very full information about them. In the case of a recent 360-KW. three-phase generator of the Heyland type, built by Kolben & Co., and designed to give a constant pressure of 5,200 volts at its terminals at all loads and a power factor of 0·8, the compounding tests were carried out on a load of practically zero power factor, and even under these conditions the full load pressure drop was only 4·8 per cent. On a power factor of 0·8 the

voltage was constant between no load and full load. The characteristics of this generator are such that on short-circuit it will give only 1·7 times full-load current with normal no-load excitation. Notwithstanding this heavy armature reaction, the generator compounds exactly at 0·8 power factor, and the exciting watts at full-load are less than 1·9 per cent. of the total output. This shows that by adopting Heyland's method a great saving can be effected in the size of the machine, for a generator which would, if uncompounded, drop 16 per cent. on non-inductive load is made to regulate perfectly.

With self-exciting and compounded high pressure three-phase generators operating in parallel, it is, of course, necessary to have equalising circuits between the generators just as with compounded direct current machines.

Mr. Heyland has proposed a modification of his method of compounding which can be used with existing machines. Instead of making the generator self-exciting, he proposes to retain the direct coupled exciter and to compound the latter. In addition to its

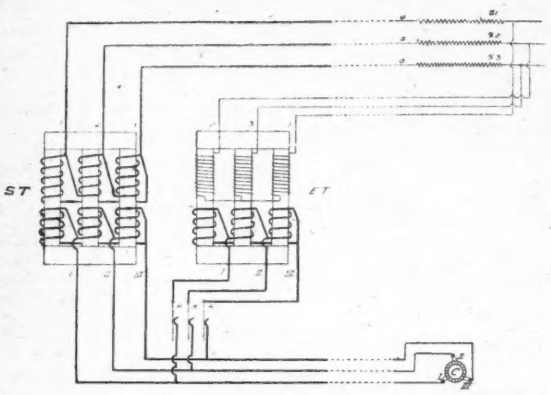


Fig. 3.—Connections of Transformers to Heyland's Commutator.

ordinary shunt winding, the exciter is provided with an inter-connected multiple circuit winding on its field magnet. This is supplied with a rectified current through a commutator, in the same way as the main generator field might be supplied in the method described above. The commutator rotates synchronously, and the current it supplies raises the voltage of the exciter.

This brings us to a large class of methods in which the exciter is operated upon by alternate currents, so as to increase the voltage of excitation. If an A.C. armature is carrying a current which is leading on the E.M.F., the current tends to strengthen the field, because at the instant when it is at its maximum, the conductors carrying it are on the same side of the pole as the field winding conductors which carry direct current in the same direction. This principle is easily applied to an exciter, so as to increase its voltage as the A.C. load is increased, and to make the increase greater when the power factor is lower. The alternate current may either pass through independent windings on the armature of the exciter, or it may be passed directly into the ordinary direct-current winding.

In 1897, E. W. Rice, jun., published a method in which the voltage of the exciter was affected in this way. Rice also describes an independent exciter running synchronously with the generator, having collector rings on the armature into which the alternate current is passed. In another method due to Mr. Rice, the alternate current which is fed into the exciter is derived from two transformers, the primary of one being connected in shunt with the generator, and the primary of the other being connected in series with the mains. A choke coil and resistance enable the compounding to be adjusted for any power factor. Machines of this type have been worked commercially on a somewhat extended scale by the General Electric Co, of America. The main objection to them is that the voltage does not respond instantaneously to sudden demands on the load.

A method patented by Mr. R. B. Ransford in 1898 is somewhat analogous to Rice's method. The alternate current is derived from two transformers, the primary of one of which is connected in shunt with the generator, while the primary of the other is connected in series with the mains. We thus get an alternate current which is proportional to the requisite exciting current at all loads. The exciter may be regarded as a rotary converter, which converts this alternate current into direct current.

M. Leblanc has constructed an exciter which so varies the current it supplies as to give almost constant voltage at the terminals of the generator for any kind of load.

E. Danielson independently invented a similar method, and M. Bourcherot has devised a method which falls under this class.

Messrs. Crompton & Co. have devised a method in which the alternate current is passed around the field magnets of the exciter, producing a wavy uni-directional current, which, by the aid of certain choke coils and resistances, is made to increase the excitation of the A.C. generator on loads of low power factor.

We now come to consider the method in which the field excitation is maintained constant, and in which use is made of the armature reaction to strengthen the field on load. Fig. 4 shows the arrangement of the generator field circuit. Each pole consists of at least two parts, a saturated part and an unsaturated part. The first is wound with a magnetising coil, and there may or may not be another magnetising coil placed around the whole pole. This second winding may be necessary for varying the normal voltage of the machine. In fig. 4 the broad pole is very highly saturated in the region marked with shaded lines, while the narrow pole on the right is unsaturated, and at no load is unmagnetised. The field rotates counter-clockwise, and as the pole depicted in fig. 4 is a south pole, it gives rise to an electromotive force in the conductors above it, which is in the sense indicated by the crosses —that is to say, away from the observer. Any current in the armature which is in phase or nearly in phase with this electromotive force will tend to demagnetise the saturated part of the pole and magnetise the unsaturated part. The flux from the saturated part cannot be changed to any great extent, while the unsaturated part becomes highly magnetised by armature reaction and increases the electromotive force of the armature. The British Westinghouse Electrical and Manufacturing Co., Ltd., have thoroughly tested this type of machine, and in all cases where the power factor is not lower than 0·85 they find it possible to make a machine hold its voltage from no load to full load. In the great majority of cases in which alternate-current generators are used, the power factor is higher than 0·85, so that a compound alternator without commutator or any complications can be supplied. The armature, in increasing the E.M.F., is instantaneous in its action. In cases where the power factor ranges between ·9 and ·95, as in a great number of lighting stations, considerable over-compounding can be guaranteed. The following are the results of a test made on a 150-KW. three-phase generator, 415 to 440 volts, 25 periods, 500 r.p.m. The generator was

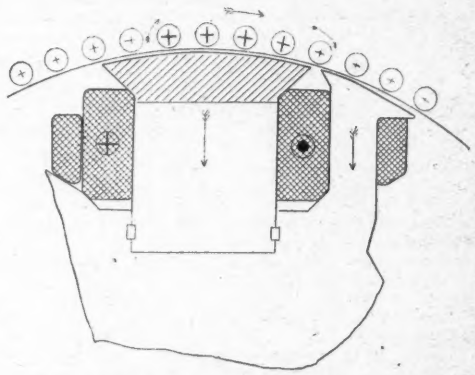


Fig. 4.—Author's Method of Compounding A.C. Generators.

belted to a shunt wound D.C. motor, and loaded on a rack of iron wire (power factor ·97). With 28 amperes in the main field coils, and no current in the auxiliary field, the voltage was 416 at no load. On throwing on a load of 150 KW., and correcting the speed, the voltage rose to 445 volts, showing a compounding of 6 per cent. between no load and full load. On another test the main field current was diminished and the voltage brought up on the auxiliary field winding. The rise in voltage on load was not so great as before. By fixing the current in the two windings at a suitable figure, it was found possible to make the machine hold its voltage exactly between no load and full load. The generator was then loaded on a 100 KW. rotary converter through transformers. The rotary ran well in parallel, loaded and unloaded, at power factors varying between unity and 0·7. The synchronising current could be reduced to a value too small to read upon the instruments by adjusting the field of the rotary. When the rotary was loaded so as to produce full load in the generator with unity power factor, a rise in voltage of 10 per cent. was obtained between no load and full load. At a power factor of 0·87 the voltage was maintained constant at all loads. The drawback to this method of compounding is that as the power factor decreases the magnetising effect of the armature also decreases, but this objection is not so serious as might at first be supposed, for in the majority of cases the generator is carrying all day the greater part of its non-inductive load. Take the case, for instance, of a station supplying principally incandescent lamps. All day the generator has to supply the magnetising current to transformers, and when the load comes on suddenly in the evening the power factor increases, so that a generator of the type described would have exactly the right kind of regulation. Similarly, where a generator is loaded with induction motors running light, a load on the motor increases the power factor, and again the generator behaves well. In cases where sudden and large draughts of power at low power factor are required, this type of generator would not be suitable.

It may appear at first sight that a generator with a field magnet shaped as shown in fig. 4, would not have a good E.M.F. wave form. It has been found that by proper design the wave form at full load can be made to approximate very closely to a sine wave, in fact, more closely than the wave form of the old simple type generator.

At no load the wave form will not depart much from the true sine wave, but will have a slightly peaked form—the form, in fact, which has been found to be most economical with transformers working on light loads.

THE AUTOMATIC v. THE MANUAL TELEPHONE EXCHANGE.*

By KEMPSTER B. MILLER.

There are two general methods of giving telephone service to a community:—

1. By what is commonly called the "Manual" system, because of the fact that the switchboards employed at the central office require manual operation.

2. By the so-called "Automatic" system, wherein the central office operator is dispensed with, switches being so arranged that they will, without the aid of human hands, perform the necessary act of connecting lines for conversation, and afterwards disconnecting them at the will of the subscribers.

The manual system may be assumed to be highly developed, as it has been almost universally used since the advent of telephony—a period of nearly 30 years.

While the automatic switchboard has been in the minds of inventors since the year 1879, it has only been put into considerable use very recently. Instead, therefore, of its development being paramount in the minds of a large number of practical telephone workers, it has been fostered till lately by but few men, some of whom were unfamiliar broadly with the details of the telephone business.

A fundamental question affecting the entire problem is this: Is it possible to make a machine serve to effect the electrical connection of any line, in a large or small group, with any other line in the group, for the purpose of telephonic communication, and afterwards to effect a disconnection when required? There can be, even at the present early stage of development, but one answer to this question—that it is. The automatic switchboard at Grand Rapids, Michigan, recently selected for the author 100 different lines chosen at random from among approximately 5,000 lines centring in that office. Some of the subscribers called did not respond, which will occur in any system; and some of the lines were automatically reported busy, which is to be expected; but in no single case was the wrong line chosen, and in but one case was the disconnection improperly secured. The verdict of a large number of the subscribers interviewed in that city is practically unanimous to the effect that they uniformly secure their connections and disconnections promptly, accurately and satisfactorily.

A prominent telephone engineer recently remarked that no machine could ever be made to perform the many and varied functions that it was necessary to teach telephone operators to do. This seems to be a statement that has very little to do with the real automatic problem.

The real functions that the automatic switchboard should be required to do automatically are those relating to the ordinary routine work of connecting and disconnecting subscribers' lines under the control of the calling subscriber. When some act needing intelligence at the central office is required, then let an operator supplement the work of the machine. To condemn the automatic switch because it will not perform all of the special requirements without the aid of human intelligence is unfair.

The author has looked into the subject sufficiently to show that no insurmountable obstacles exist that would prevent the successful establishment of party line, common battery and measured service working, though a good deal of work will be necessary before they can be commercially adopted. From the technical standpoint, therefore, the automatic telephone is possible. The question now arises, Do the subscribers like it? The evidence all seems to point in one direction—they do. At Grand Rapids, Mich., Fall River and New Bedford, the service has been maintained for several years, and seems to be much liked.

The question also naturally arises, Is not the automatic switchboard and necessary subscribers' mechanism too complex to be maintained in proper working order without undue cost? It is perhaps too early to decide this question. There is not enough evidence one way or another. Judging from the past, however, the tendency of the industrial achievement seems to be to do things automatically.

For an exchange of 5,000 lines served by one office, the cost of automatic equipment, including telephones, may be taken at $35.00 (say, £7) for each individual line. In manually-operated exchanges the corresponding cost is not far from $25.00 (say, £5) per line. The difference becomes greater—that is, more in favour of manual—for smaller offices—and smaller, or less favourable to the manual, in larger offices.

Whether or not the depreciation on automatic apparatus should be taken at a higher rate than that on the manual is a question that we have not at present sufficient data or information to determine. Much of the depreciation in manual telephone apparatus is due, not to the fact that the apparatus wears out, but rather to the fact that the apparatus is rendered obsolete by new inventions. That the same will be true in the case of automatic apparatus cannot be doubted, but it is a good point to bear in mind that if telephonic development should point towards automatic apparatus to the exclusion of manual, and should prove the superiority of automatic, then the highest developed and newest manual apparatus will depreciate greatly in value by that fact alone. It does not seem unreasonable, therefore, to place the rate of depreciation on both manual and automatic apparatus at about the same figure.

In point of maintenance the advantage must be conceded to the manual. Automatic apparatus is especially at a disadvantage at the subscribers' stations, and it is really at this point that the automatic system seems to involve a poor engineering feature, and as at present developed for large work, it takes a step backward by re-introducing the local battery, though the disadvantage is by no means as great as it would have been several years ago, because of the fact that modern dry batteries as now made are far superior, all things considered, to anything heretofore available.

Taking the automatic system as we have reason to believe it will exist in the future with no local batteries, it will still possess, as far as we are able to see, a more or less complicated impulse transmitting device, by means of which the subscriber will be able to direct the movement of the switches at the central office. Complexity not only of mechanism but of function is thus introduced at the subscribers' instrument, and this seems to be an inherent disadvantage to all present schemes of automatic exchange working. This, of course, is another factor that must be weighed in considering the relative economies of the two proposed methods.

A point which has not been mentioned in print before, and under certain cases seems to be of great importance, is the matter of trunking between two or more automatic offices in those cities that demand, by the distribution of their subscribers, more than one office. There is very little difference in the time the trunk is held busy in the two systems, the length of actual conversation being assumed to be the same in each case. The reason for this is that, while the automatic gains in this respect in the release, it loses something in the making of the connection.

In the present automatic system, group the trunks as you may, a subscriber has access to 10 trunks only in order to secure a connection to any other office. It is true that some other subscriber may have access to another 10, or to the same 10, but no one subscriber can reach more than 10. This seems to be a grave objection to the use of automatic systems as at present developed, in those communities where several offices must be employed and where traffic is such as to demand a large number of trunks between offices.

There are features of the automatic system which may make it so popular as to force upon the owners or prospective owners of telephone industries a serious consideration of the doctrine of expediency. This is by no means the least of the important things to consider.

* Abstract of paper read before Section G.—"Electric Communication"—International Electrical Congress, on September 13th, 1904.

PURE FEED WATER.

In Mr. Rockwood's paper on "Condensers for Steam Turbines," read before a recent meeting of the American Society of Mechanical Engineers, it is stated that very pure feed water is not in itself desirable, being only better than very impure water, for it pits the tubes and water legs of steel boilers unless some lime is added.

Water is recognised as a very universal solvent, and it may be the case that perfectly pure water has corrosive effects; but there are good reasons to doubt this, or at least there are sufficient reasons to justify the suspicion that other causes should be thoroughly investigated before falling back finally upon the corrosive action of pure water. Absolutely pure water is very difficult to secure. Nominally it is a product of surface condensation in steam engineering, but actually it is not pure water that leaves the surface condenser, for it is generally more or less polluted with oil, and the freedom from oil which is secured in turbine work is one of the many reasons advanced in favour of steam turbines as compared with the reciprocating engine, which is still apt to clamour for oil. Theoretically, of course, mineral cylinder oils should not cause boiler corrosion, but probably some corrosive effect attends on their use, for acid plays a part in oil refining and may gradually accumulate in the boiler fed with water from a surface condenser even if the oil has been eliminated. An acid oil, in fact, would be cleared of its acid by the steam with which it is atomised in passing through the engine. Mr. James Weir, of Glasgow, has, however, always insisted on purifying feed water of its gases, and not allowing the water to enter the boiler until it has been raised to the temperature of at least 212° F. He has demonstrated considerable economy to be possible where steam is taken from the intermediate receiver of compound engines, and employed for feed-heating purposes after some work has been got from it. Raised to 212° F., all the gases dissolved in water are driven off, and the escape of such gases is provided for in the feed heater, so that they may not enter the boiler. It would appear that pure water is a fairly powerful solvent of gases; otherwise, how is it to be accounted for that water from a surface condenser just reduced from high pressure steam so soon appears to carry a volume of air back again to the boilers?

May it be assumed that this air-purged water does rapidly take up carbon dioxide and oxygen from the atmosphere? Or is it that boiler corrosion has arisen from the small percentage of make-up water? Whatever the cause, it appears certain that the gases which are contained in feed water do exercise corrosive effects, and that it is on this score, apart from other reasons, a positive advantage to feed boilers with hot water. It is a matter of common observation among those who have the opportunity of seeing the internal conditions of steam boilers, that in many cases the only corrosion visible is in the region of the feed inlet. Water charged with more or less gas carries this gas to the plates in the near vicinity, and numerous pittings are formed. Further away no such pittings occur, for the gases are soon driven off and escape with the steam.

These gases are considered by many engineers to be more particularly active at the moment they are set free than subsequently; that

is to say, they are suspected to be in that nascent condition which is explained by some to be due to their being in an atomic state prior to having combined to form the normal or molecular condition.

Whatever the actual facts, present knowledge points to the desirability of preventing the entry of gases to steam boilers, and to the probability that to these gases rather than to pure water that corrosion is due.

At the same time it is not undesirable to maintain a faint alkalinity within a boiler, and this can be done as well by means of lime as by soda. A small dose of caustic lime is not only likely to ensure alkalinity, but it will also aid as an absorbent of carbonic acid gas, if any is present in feed water, and will help to produce a thin lime carbonate scale. No fear need be entertained of such scale becoming excessive, for it will soon loosen and disappear when the lime treatment is temporarily stopped.

Oil, of course, should be removed from feed water because of its danger, though this is rendered far more serious when water contains carbonate of lime or magnesia. Alone, oil is still very undesirable, though perhaps less so when entirely of mineral origin. Gases can be cleared more easily than oil, and they certainly should be thoroughly removed, for they depreciate the vacuum obtainable below that proper to the condenser temperature. After heating to 212° F., therefore, there should be provision for trapping out air from the feed water, and after the air has thus been trapped out the feed should be further heated to the full temperature of the boiler before it enters the latter.

The boiler will then become what its name seems to imply, namely, an evaporator only. When called on for this duty alone, it will act better and more efficiently than if made to perform feed-heating duties as well. Some engineers deny this, but the general concensus of opinion seems to be in favour of this view.

SIMPLE OR COMPOUND ENGINES.

The acceptance of the compound engine as suitable for all manner of electrical work has probably had its origin in the fact that the compound engine when engaged on a steady load at or near its rating of best economy, is a more economical machine than the simple engine. But it by no means follows that it must of necessity be a better engine to employ under other circumstances. The economy of an engine depends upon its first cost, the ratio of the internal surfaces to the weight of steam used in unit time, and the amount of expansion. There is for each type of engine a certain ratio of expansion that, combined with the capital charges, can be shown to give the most economical results. In cases where the engine works for but a few hours per day, the capital charges tend to assume a more serious proportion of the whole costs. Where the hours are long, the capital charges will be spread over a longer period. These considerations point to the economy of the compound engine on electric tramway work with days of 16, 18, or even 20 hours' duration, and to the use of less elaborate engines for loads of short duration.

At the same time, in tramway work the load though of long daily duration is of a very fluctuating order, and the ratio of the mean load to the maximum is low, varying from about 16 per cent. upwards, and only passing 60 per cent. in quite extensive systems. If a compound engine is employed for this work, it is obvious that it must be of such dimensions that with the latest possible cut-off in the first cylinder the engine shall be capable of dealing with the maximum load. Such an engine is therefore very much underloaded on the mean load and enormously too big for the minimum load periods. Considering these facts, together with first cost or capital charges, and the wastefulness of underloaded engines generally, there is good reason to suppose that it may be worth while to inquire into the merits of simple engines for such duty, especially when superheated steam is available.

Some such investigation in non-condensing engines has been presented in a paper before the American Society of Mechanical Engineers at their December meeting by Mr. S. H. Bunnell, who recognises the wide gap between ideal performances of engines on steady load and the very poor results in practice in the case of the power plant of the tall office building, the operation of which, with numerous elevators, is not altogether dissimilar from a tramway service. Especially when non-condensing, the number of expansions of the steam is limited to a figure not unsuitable for the simple four-valve type of engine, for expansion cannot economically be carried to such a point as to produce a loop of negative effect in the toe of the indicator diagram.

To compound such an engine is to make such looping almost inevitable under the conditions of practice. Actual practice often shows, says the author, that worse results accompany compound than simple engines in large office buildings. The only advantage of the compound engine appears to be the division of the temperature range between two cylinders.

An investigation of a number of cases appears to show that costs are divisible as to $\frac{1}{2}$ for labour; $\frac{1}{10}$ to $\frac{1}{3}$ for interest and depreciation, and $\frac{1}{3}$ for coal.

The minimum load has been observed to be as low as $\frac{1}{25}$th of the maximum, but from $\frac{1}{8}$th to $\frac{1}{10}$th is more usual. Obviously the engines ought to be designed to be most economical at some point below their maximum loading, which is really required for an hour or two in the afternoon of the winter months only. Diagrams and tables are given, and engineers are urged to make a study of loads before designing plant.

The conclusion is that the single-cylinder four-valve engine has a far greater range of capacity, with reasonable economy, than the non-condensing compound engine, and is to be much preferred for the power plants of large buildings.

BRIGHTON MUNICIPAL TECHNICAL SCHOOL.

On December 21st Sir William White, K.C.B., late Chief Constructor to the Royal Navy, visited Brighton to perform the opening ceremony of a new wing to the engineering department of the technical school. The opportunity was taken of combining the opening ceremony with the annual distribution of prizes, which usually takes place in February.

Sir W. White, accompanied by the mayor, Alderman Blaker, the principal of the school, Dr. Draper, and a numerous company of ladies and gentlemen, first made a tour of the new buildings. Leaving the engineering laboratory, they entered the new engineering workshop. At the further end of this room, Sir William turned on the steam to a new 30-H.P. steam engine, by Messrs. Marshall & Co., Gainsborough.

Passing next to a 20-KW. steam turbo-generator, of the De Laval type, by Messrs. Greenwood & Batley, of Leeds, he also set this in motion for the first time. The company next inspected several gas engines and machine tools, which had been removed from other parts of the school, and then went downstairs to the boiler house. Installed here is a new Babcock & Wilcox boiler, capable of evaporating 1,300 lb. of steam per hour, at a pressure of 160 lb. per square inch.

After visiting the dynamo room the company adjourned to the drawing hall. In the course of an excellent address, Sir William White stated that the average man never realised to what an extent he owed the comfort of his existence to engineering. He had recently visited New York, which would have been uninhabitable but for the work of the engineer, and he took it as a very favourable sign that excellently equipped institutions like this were now springing up all over the country, the combined effect of which would be very much to the benefit of the country generally. What was wanted now was more co-operation of the large employers of labour with the various education authorities; he was glad to see that the L.B. & S.C. Railway Co. were not behind in this, and that they offered several prizes every year for their employés attending the school, but they might do more than they did, and he went on to cite the encouragement given by the L. & S.W. Railway Co. to their employés attending the Battersea Polytechnic as an example of what might be done. Every encouragement, he was glad to see, was given to all classes of students, and he considered many of the courses as laid down were admirable. It was no use trying to take up the higher branches of a subject until a good foundation had been laid, but that foundation should be laid elsewhere. The school curriculum was laid on a very broad basis, and did not include technical subjects only, but also commercial and domestic classes.

Sir William White, in the evening, distributed the prizes to the successful students, and a conversazione followed, for which the whole building was thrown open to the students and their friends.

The present building has been opened for seven years, and was built at a cost of £50,000, this being the first extension. The number of students in that time has risen from 700 to 1,046, and the average attendance from 960 to 1,726. The new buildings consist of one large workshop 75 ft. long × 45 ft., containing working benches for 14 students, and is well equipped with modern machine tools driven by a 12-H.P. gas engine by Messrs. Tangye. There are several screw-cutting lathes, the largest being a 10 in. by Messrs. Archdale, of Birmingham, together with others, including a capstan lathe by Messrs. Herbert, of Coventry, planing, slotting, drilling and other machines, which together form a well-equipped shop. At one end is the new Marshall 30-H.P. horizontal compound steam engine; this engine can also be run as a simple engine, using either the high or low pressure cylinder as desired, and both cylinders are so arranged that the amount of water consumed can be easily measured.

The engine is fitted with a surface condenser, the arrangements allowing the exhaust steam to be sent either to the condenser or direct to the chimney as desired. The air pump is worked from the tail-rod of the low-pressure cylinder, and can be uncoupled in a few minutes when it is desired to run non-condensing. Both cylinders are provided with expansion valves, the one on the high-pressure cylinder being worked by a governor of the Wilson-Hartnell form. To facilitate the study of both types of governor, the engine is also provided with a throttling governor. The power developed by the engine is absorbed by two rope brakes placed on the fly-wheels, the heat generated being carried off by water circulating in the rims. Close to the steam-engine is a 20-KW. De Laval turbine, direct-coupled to two generators, which supply light and power to the building; the working pressure is 150 lb. per sq. in., and the machine runs at about 22,000 r.p.m. The armatures of the generators are on parallel shafts, and are geared down to 2,200 r.p.m.; they can be placed either in parallel or series, giving 80 amperes at 230 volts, or 40 amperes at 460 volts. The surface condenser on the steam engine can be used when testing the turbine. To control the turbine, a highly-sensitive governor operating the main stop-valve has been fitted, and by means of this the speed variation from no

load to full load is kept within the limits necessary for maintaining constant voltage at the generator terminals. The dynamos are of the shunt-wound type, with a common yoke. The new Babcock and Wilcox boiler is capable of generating 1,300 lb. of steam per hour at 160 lb. per sq. in., the tubes being 4 in. diameter, and 12 ft. long. The new plant in the dynamo room consists of the following:—One 22-H.P. motor, by the Lancashire Dynamo & Motor Co., running at 730 r.p.m. on 230 volts; one 15-H.P. motor, by Messrs. Royce, running at 850 r.p.m. on 460 volts; one Fynn rotary converter, by Easton & Anderson, having an output of 5 KW., and fitted with six slip rings, thus giving one, two, or three-phase currents.

Two dynamos by the Lancashire Dynamo & Motor Co., each of a maximum output of 6·5 KW. at 230 volts are direct coupled on a common bedplate, and fitted with a water-cooled brake. They are also equipped for testing by the Hopkinson method.

The remaining machines include one dynamo, by the E.C. Co., 4 KW. at 50 volts, with shunt and compound windings; one 2-KW. balancer set by the Westinghouse Co. for a three-wire 55-volt supply; one rotating-field alternator, by Crompton Co., of a maximum output of 5 KW., capable of generating one, two or three-phase current; and one single-phase induction motor, by Crompton Co., giving 3 H.P. at 230 volts.

The necessary switchgear has been supplied by Messrs. Suter and Co., Ferranti & Co., and the B.T.H. Co., and the instruments by Messrs. Nalder Bros. & Thompson.

In the mechanical engineering laboratory a new 50-ton testing machine of the horizontal type has been installed by Messrs. Greenwood & Batley, of Leeds, for testing either tension, compression, or bending, the load being applied by means of an hydraulic ram.

For small work a 2-ton wire testing machine has been supplied by Messrs. Bailey, of Manchester, together with a cement tester, by Messrs. Adie, of London, and many other machines of less importance.

In the electrical laboratory there are all the necessary instruments and apparatus for testing capacity, resistance, E.M.F., flux density, self and mutual induction, magnetising force, &c. The laboratory is supplied with current by means of overhead conductors, from a multiple bus-bar distributing board connected with the various cells of a battery.

In conclusion, we have to thank Dr. Draper, the Principal, and his assistants, for the facilities granted in compiling this account.

ELECTRICAL DEVELOPMENT IN CANADA.

To what extent are the electrical manufacturers of the United Kingdom catering for and securing the electrical trade of that most promising of all British Colonies, Canada? And what prospect is there of this country doing more in this direction as the years roll on and Canada develops her almost limitless resources?

We believe these two questions to be of serious import, and are inclined to the belief that their real seriousness has never been properly appreciated, for had they received all the attention that they deserve, our electrical connection with Canada would be closer than it actually is. Not that Canada has yet reached a very advanced stage of electrical development, but a commencement on fairly extensive lines has been made, and it behoves the British manufacturer to give attention to the field that is opening before progress there gets any further.

It is sometimes possible to form an idea as to the position of the British manufacturer in the struggle for Colonial and foreign trade by a study of the technical publications appearing in the countries concerned, and particularly of their advertisement pages. If we apply this rough sort of test to Canada, where there are only one or two publications having direct connection with electrical matters because of (1) the limited development, and (2) the attention which the United States electrical journals devote to Canadian affairs, we find that the interest taken by our home manufacturers is indeed limited; of local agencies there are a few recorded, but of direct representation and of branch houses exclusively devoted to the furtherance of the interests of one particular firm, we cannot say that there are even a few examples, for there are none, if our examination is an accurate one. As we have said, it is based upon the advertisement pages of Canadian contemporaries, and we suppose that where so extensive a territory has to be covered, advertising is one of the most likely means of bringing buyer and seller—who may be very far apart—into touch with one another.

It is difficult at this distance and without specialised knowledge to fully understand the exact reasons for what appears to be inattention to the Canadian market. It may be that with an incomplete view of the situation and the prevailing conditions our manufacturers fear that the possible keenness of competition with the United States would make the game hardly worth the candle. Or it may be held that the time is not yet sufficiently ripe for much thought or expense to be devoted to the market. But is it not true that the development, up to the present time, has been profitable in orders to the manufacturers of the States? Is it not equally true that the latter continue to give unremitting attention to the market? These facts should answer the suggestion of unprepared soil, for if Americans think it worth while to cultivate the trade in Canada in spite of the tariff walls which exist between the two countries, it ought not to be an impossible task for us. We do not forget that the British Westinghouse Co., though claiming freedom to trade in all other parts of the British Empire, excepted Canada from its agreement with the American Co. five years ago, on the ground that its needs could be more economically supplied from the Pittsburg works. But that was when the tariff conditions were more favourable for Americans than they are now. There is the cost of rail carriage from Pittsburg to set against the freights by boat plus rail charges from this country. Moreover, whatever the peculiar difficulties may be, we must not overlook the fact that at least two leading electrical manufacturing firms in the United Kingdom have booked valuable contracts in Canada during the last two years, and we have heard it said that, for certain classes of material, the British home manufacturer is well able, if he choose to face the position resolutely, to meet American competition on Canadian, and even on American soil, though tariffs be high.

The attitude of the American electrical suppliers at the present moment is deserving of careful study by every reader of the ELECTRICAL REVIEW who hopes for an extension of British electrical business in Canada. The New York representative of the *Times* shows, under date December 2nd, that many American manufacturers at the present time are engaged in seriously considering the advisability of erecting branch factories in Canada in order to retain their business relations with that country.

The claim seems to be generally made that under the "Retaliation Act" the duties on American manufactured goods will be so high that they will be practically prohibitive. In order to retain their trade with the Dominion, therefore, many American concerns will probably invest a portion of their capital in Canada and build branch factories. This will give them the additional advantage of being able to export the goods manufactured there to England and reap any benefit there may be given to Canadian-made goods imported into England. The United States Steel Corporation has had a staff of experts in Canada reporting on this possibility, and this is only one of the many manufacturers who are doing the same thing. They would be run, as far as possible, as Canadian institutions, and would be incorporated under the laws of the Dominion, but the capital behind them would be American. Several of these will probably be started when the Canadian Niagara Power Co.'s plant at Niagara Falls is in a position to supply power in its district, which will probably be in April next. The movement is likely to be an important one, and may indicate the transference of a large proportion of the export business of the North American Continent across the border.

Is it not possible that this sort of thing, if it touches electrical manufacturing, may, if carried far, while aiding in the excellent work of general Canadian development, to a large extent shut out from the market electrical firms in this country who, as years go by, will depend more and more upon their relations with foreign countries? And if this be so, what should be the attitude taken up by the British manufacturer to secure for himself a fair share of whatever there is to be made? The establishment of large American electrical manufactories on the Canadian side of the Falls should enable manufacture to be undertaken more cheaply than it could be done from this country if the cost of freights, &c., be added. Is it outside the range of reasonable possibility that some of the leading firms in this country who have had wide experience in, and have established a good reputation for, British electrical machinery, and consequently find it easier to command capital than others do, should seriously consider whether there may not be Anglo-Canadian manufactories established and businesses built up there?

If in Canada, Australia and so on, it is found possible to establish manufactories on an economical and profit-earning basis, much of the work that we are looking for in the future will not reach these shores at all. American and other rivals will not fail to grasp these features of the situation, we may be pretty sure of that, for their trade activities in the lands which claim relation to the Mother Country, have long had a very marked effect upon the course of business.

While we are referring to this matter, it may be useful to remind those concerned, of the complaint which appeared in our columns early in the present year from "A Canadian" during his stay in this country. He said that the cry of bad trade was not surprising if British manufacturers failed to take the necessary pains to meet the requirements of customers, and adopted the attitude of "Take what we've got, because we don't make what you ask for!" The charge was strongly refuted by a number of representatives of the line of industry affected, and our correspondent may have been to some extent mistaken. Nevertheless, the warning is a necessary one, for British manufacturers did get for themselves such a reputation a few years ago in many foreign markets, and it is for them to see to it, by keeping up to date and in constant touch with the market and its requirements, that any disrepute of the kind mentioned is falsified by their actions now.

It may be of some value if we give a few particulars as to the electrical development of Canada as far as it has gone, and in this connection we are indebted to an article on "Electrical Progress in Canada," which appeared in a recent issue of *Cassier's Magazine* from the pen of Mr. George Johnson, statistician of the Dominion of Canada. The figures as to telegraphs are :—36,780 miles of line, 96,728 miles of wire, 3,004 offices, and just under 5½ millions of messages per annum for 1903, or about one message per head of population, but these returns are not complete because the Canadian system and business of the Western Union Telegraph Co. are included with that company's United States figures.

Telephonic communication is in use to the following extent :—There is one telephone instrument to every 65 persons on the average. There are 56 companies operating, and 81,500 instruments connected, and the messages for 1903 numbered about 254 millions. Mr. Johnson remarks that Canada appears to be making great strides forward in the use of the telephone, and British Columbia has come within measurable distance of Stockholm, where there is said to be one telephone to every eight persons. Some interesting illustrations are given by the author to show how useful the telephone is becoming in the fruit-growing valley of Nova Scotia, where fruit-dealers are notified by telephone that a vessel due to leave a few days later has so much space left for a cargo of apples. The dealers, by conference with sub-agents, followed by prompt action, are able to meet the case and get their consignments through speedily without subjecting the stock to adverse weather conditions while waiting at wharf.

In the matter of electric railway traction, there are 46 systems included in Mr. Johnson's returns, an increase of two for the year. There are 454·75 miles of single track, and 192·54 miles of double, employing 2,053 motor-cars and 298 trailers, with 109 snow-sweepers and ploughs. About 168 millions of passengers were carried, and 40 million car-miles were run. The paid-up capital of these undertakings is about £6,000,000, and the bonded debts £3,500,000. The gross expenses for the year were £1,000,000, and the gross earnings about £1,555,000. The population of the Dominion was carried about 31 times. It is pointed out that these railways are doing well, and give promise of doing better; the electric lines, which, of course, include what we should call tramways, carry about eight times as many passengers as the steam railways. The first electric line in Canada was that of Ottawa, opened in 1891.

Turning now to electric light, heat and power development, we find that there are 316 establishments with 1,786 employés, the capital invested being about £4,000,000, and the wages bill £180,000. The Province of Ontario has witnessed the greatest development in this direction, for it has 199 undertakings, as against only 48 in 1891. Of these plants, about 100 use coal or wood, about 60 water-power, and 35 steam and water. The 316 plants represent 324 different places lighted electrically, and these in 1903 had 14,780 arc and 1,212,861 incandescent lamps. It appears that there are 34 municipalities in Ontario supplying themselves with electric light and power.

In respect of the manufacture of electrical appliances and supplies, considerable progress is said to have been made during recent years. Establishments employing five hands and over numbered 25 in 1901, employing 1,922 hands, and representing a capital of about £1,050,000, with an annual wages bill of £170,000. There is also a considerable number of smaller establishments.

In imports, too, there has been great progress; but, of about £500,000 worth of electrical material imported during the year ended June 30th, 1904, all save about £15,000 worth came from the United States! These U.S. exports included electric light carbons, motors, generators, batteries, telegraph and telephone instruments, electrical apparatus &c. Mr. Johnson says that the outlook for Canada is "one that shows the country going forward by leaps and bounds in its applications of electricity," and he gives the electrical engineer a bit of advice by saying that in this profession, more than in any other, "a man has to be wide-awake all the time, or he will be left behind, even while he is positive he is well to the front."

We believe that anything that our readers may be able to say regarding this subject of our electrical trade with Canada, and the outlook therefor, will be of considerable interest just now, so that if anyone has any information to impart, which may help toward greater development, and assist British manufacturers and traders in their consideration of the matter, we shall be glad to hear from him.

Since the above remarks were written, an interesting letter directly bearing on the subject has appeared in the *Times Commercial Supplement* under date Winnipeg, November 29th, from Mr. A. H. Berry, who is now travelling, for the second time, in the Continent of North America, having visited every large business centre in Canada and the United States. He says :—

Although Canada is very sparsely populated, her natural resources are exceedingly great. One may travel on the railroads for days and months and see nothing but farm, lumber, and mining lands, and the persons engaged thereon are very heavy consumers of manufactured goods, as are all other persons engaged in other businesses having their foundation on this natural wealth. Canada, although showing a decided preference for the mother country, purchases most of her goods from American manufacturers, and the fault of this lies entirely with the English manufacturers. The conditions here call for goods somewhat different to those manufactured for home demand in England and other countries, and the American manufacturer is sensible enough to realise this and cater accordingly, while the English manufacturers attempt to compel their customers to accept something they do not want, forgetting that the one paying for the article is certainly entitled to demand something in accordance with his requirements. Another reason why the English manufacturer is at a disadvantage is the length of time that elapses before a Canadian buyer can have his orders supplied by an English firm. If the English manufacturers would first study the special needs of this country, and, secondly, store goods to meet the same in bonded warehouses in convenient centres of Canada, and have their representatives on the spot to meet promptly their customers' orders, the American manufacturers would soon lose the hold they have gained on the Canadian market.

Surely this is sound common sense, and need not entail much expense in being put into operation. Let a company of English merchants engage warehouses in the east and western cities, and store them with goods specially designed for Canadian trade; let them send out their travellers, and they cannot fail to capture the Canadian trade. The duties would not become payable until the goods were removed from bond. Therefore all the expense that need be incurred would be the rent of the warehouses and the initial expenses of the campaign.

Railroad travelling in Western Canada is, on account of the rough character of the country traversed, very slow. Therefore, under the present order of things, a Western merchant ordering from an English house, has to wait sometimes six weeks to two months before his orders are filled. Is there any wonder, then, that the American merchant, who has warehouses stocked with goods in convenient centres, and who will also supply the class of goods demanded, gets the preference?

I say to English manufacturers: "You pay less for labour than your American rivals. Wake up! wake up! and send out men to study the needs of this rapidly growing population. Have Canadian goods and your representatives always on the spot to meet your customers, and your American rivals are beaten; otherwise the American will capture for ever the whole of the trade, which, in another quarter of a century, will be beyond your wildest dreams; and then you may sleep for ever, for it will be too late.

THE UNCERTAINTY OF FUSES.

[COMMUNICATED.]

Fuses, as commonly constructed, have a somewhat unenviable reputation for uncertainty in action. This may arise from several causes, amongst which might be mentioned loose terminals, due either to carelessness, or to "backlash," caused by alternate heating and cooling of the terminals; started by changes in the surrounding air, and accentuated, when current is passed through them, or by vibration. After a time, such a fuse would melt, owing to excessive heating, at one or other terminal, although it might be carrying a current below the normal at the time.

Again, if the fuse wire has been adjusted from a table of fusing currents for long wires, it will generally carry about a third more current before it "blows." For general purposes, when the length and the diameter are variables, the formula—

$$c = \frac{b\sqrt{d^3}}{l^{\frac{1}{2}}},$$

where b is a constant, may be applied (*vide* Herzog and Feldmann, *Electrische Leitungsnetze*).

Stranded fuses are frequently disappointing, since their current-carrying capacity is not proportional to the number of strands, but to some lower power.

If we assume that the fusing current of a wire when consisting of a number of stranded conductors is equal to that of a solid conductor having an equal cross-sectional area of metal, then, assuming Kempe's law, $c = ad^3$, we obtain—

$$c = c_1 n^{\frac{3}{2}},$$

c_1 being the fusing current for one strand.

For ordinary purposes, such as house fuses, &c., this will be sufficiently near the truth. The difference, of course, increases with the number of strands, the cooling effect of the air spaces, &c., being then more marked.

The following table shows the result of an experiment on this matter:—

Current		Calculated current $c_1 n^{\frac{3}{2}}$.		Number of strands.
6·7	...	—	...	1
12·5	...	12·7	...	2
15·4	...	15·3	...	3
20·1	...	18·9	...	4
24	...	22·4	...	5
29	...	25·7	...	6

In cases where the wires are not stranded, but laid approximately parallel, the cooling surface will be greater, and the current-carrying capacity slightly increased. If the fuse is spread in the centre, then, of course, its current carrying capacity will be higher still, but will not be proportional to the number of strands, since it must be remembered that a fuse breaks at the top end, if vertically arranged, and here the wires are necessarily close together.

With regard to the time of fusion, experiments seem to show that this follows some such empirical law as—

$$c\,t = a + b\,l,$$

where c, t, are current and time respectively, and a and b are constants. The following figures show this:—

Current in amperes.			Time in seconds.
8·4	...	...	2·8
10·7	...	...	7·5
12·25	...	...	4·5
13·4	...	...	3·2
16·6	...	...	2·1

Necessarily the time of fusing will depend on the surroundings of the fuse, and whether or not it is mechanically supported. Before the fuse can possibly melt, the comparative cold of the terminals, surrounding air, oil or chalk will require to be neutralised. One would, therefore, expect that surrounding a fuse by a substance which has a sensible heat diffusivity would tend merely to make the fuse action more sluggish. See table below:—

Current in amperes.	Time in seconds.	Remarks.
20	6	All wires horizontal, and 6 cm. between terminals.
25	10	One support at middle.
25	25	Two supports near ends.
31	160	Supported along length.

Recently E. Oelschlager, experimenting with an oscillograph (*vide Electrotechnische Zeitschrift*), found that the energy necessary to fuse a given wire was practically independent of the current. This seems obvious from the foregoing, since the bulk of the heat will vanish in the terminals and surroundings of the fuse. If the length of the fuse varied within certain limits, it is possible that the energy would not vary, since the change in the mass of the wire would probably be insensible, compared with that of its surroundings.

Calculations based on the specific heat, resistance, &c., of the wire at a given fusing temperature are necessarily very rough approximations, because very little is known of the constitution of the wire at a high temperature, and, again, because the temperature itself is a very doubtful quantity. It is perfectly easy, by adjusting a lead fuse of suitable length and diameter, to pass a comparatively large current through it, keeping it glowing brightly for a long time. In this case, the wire is far above its melting temperature, which can be demonstrated by melting a fine wire of, say, copper, in contact with it. Further, the distribution of temperature along the wire is by no means constant; hence the use of lead-tin alloys, &c., to prevent "a rise of temperature to a dangerous extent" in the fuse wire, seems a little ridiculous, since, in the case of a "dead short," this material will be at a white heat.

When the fuse wire does "blow" a very complex state of matters is set up, which perhaps at present is hardly completely understood. Fuses, as a rule, are "designed," if we can use that expression at all in this case, not so much to prevent an excessive current passing through them, as to prevent the formation of an arc.

Now, the pressure necessary to keep an arc burning is rather complex, the expression of Frölich being—

$$v = a + b\,l,$$

where v is the voltage of the arc, a and b are constants, and l the length of the arc.

Later, Mrs. Ayrton has shown that both a and b depend on the current passing through the carbons of the arc, the expression being—

$$v = a + \frac{\beta}{c} + \left(\gamma + \frac{\delta}{c}\right)l,$$

where a, β, γ, δ are constants. With a hissing carbon arc the pressure is found to be independent of the current. With metallic terminals, a and b in Frölich's formula depend on the temperature of volatilisation of the material (*vide* J. J. Thomson's "Conduction of Electricity through Gases"). Aron has also shown that a pressure of 2,000 volts alternating at ordinary periodicities is necessary to maintain a metal arc, and Duddell (*Proceedings* of Institution of Electrical Engineers) has shown that a direct current metal arc is very quickly extinguished, a break lasting $\frac{1}{2700}$ second seemingly being sufficient with metal electrodes. However, this last point depends on the amount of metal vapour, and consequently on the current passing. The value of a for terminals of different metals, varies from 10 to 28 volts.

One would expect to find these researches having some effect on the design of fuses, but this does not appear to be the case. The current that passes through a fuse on short circuit does not seem to receive very much attention; the length of fuse generally bears some occult relation to the voltage of supply, and, whether direct or alternating, does not appear to make very much difference, except, perhaps, that the latter requires more stringent design. The German regulations again specify a length (for a given voltage) varying in some way with the current. Since, however, on short circuit the fuse wire is carrying an excessive current, any relation between length and "normal fusing" current is surely out of the question.

If forming an arc on short circuit depends on the quantity of metal vaporised, then, surely, it is the *short circuit current* which should be taken into consideration, and not the "normal fusing current," whatever that means. The fact is, that, like prime numbers, the "number of fusing currents for a wire is infinite," and depends on time, &c., referred to above.

Meanwhile, a satisfactory fuse eludes engineers like the "snark," and since they have evidently "tried all they know and done all they don't" in their endeavours to pro-

duce a scientific fuse, it will probably be necessary for some "pure," or, perhaps, we should now say "raw" scientist," to come along and set them on the right lines.

It seems to the writer that the "environment" of the fuse wire should receive a little more attention, since it apparently cannot escape from the "Darwinian Evolution Theory," and, so long as fuses are placed in iron boxes promiscuously, they will be sluggish in their action.

Further, is it not rather too much to expect a fuse to volatilise with a given current in a given time, and also to extinguish an arc? This attempt to make a fuse satisfy a dual condition is apparently where all the trouble comes in.

Possibly the solution of the difficulty will be found in the proper understanding of a hissing metal arc; in any case it is to be hoped that the present occult regulations for "lengths" of fuses, arrived at "somehow," will shortly be displaced by something more scientific. Meanwhile, the strip notched in the centre, of all places, and squashed at the ends between two large terminals to conduct away heat readily, and stamped with the mystic stamp "200 amperes" for its "normal fusing current," will continue to uphold its reputation for generally unsatisfactory conduct. Is this to be regarded with wonder under such circumstances?

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

27,018. "An electric automatic stopping device, applicable to knitting and other textile fabric machines." I. H. Fabsons and H. R. Waddington. December 12th.

27,028. "Improvements in flexible continuous covering for plough-way of electric conduit system and apparatus on cars for manipulating the said covering." T. T. Dewhirst and B. Biggs. December 12th.

27,033. "Improvements in electro-magnetic releasing mechanism for electric switches and cut outs." C. M. Dorman, R. A. Smith and H. G. Baggs. December 12th.

27,060. "Improvements in controlling devices for electric motors." B. C. Kenyon. December 12th.

27,082. "Improvements in or connected with electrical counting apparatus, more especially applicable for use in connection with ships' logs." Lollond and Co. and T. Crawford. December 12th.

27,083. "Improvements in the control of electric motors and in apparatus therefor." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 12th.

27,095. "Improvements in electric telephony." C. A. Randall. December 12th. (Complete.)

27,096. "An improvement in electrical signalling apparatus, particularly applicable in fire alarms." C. D. Abel. (Siemens & Halske Act.-Ges.) December 12th. (Complete.)

27,100. "Improvements in and relating to electric motor apparatus." Mavor & Coulson, Ltd., and H. A. Mavor. December 12th.

27,114. "Improvements in and relating to operating gear for moving the points on electric and other tramways." A. C. Vilgin. December 12th. (Complete.)

27,115. "Improvements in reverse current circuit-breakers and indicators for alternating currents." L. Andrews. December 13th.

27,135. "Improvements in hangers or ears for overhead electric trolley wires." H. Heap, J. Bailey, T. Brierley, R. Billington, A. Richardson, J. Haydock, and T. S. Jones. December 13th.

27,168. "An improvement in the method of automatically regulating the voltage in electric light and power circuits with varying loads." M. J. E. Tilney. December 13th.

27,185. "Improvements relating to electric conductors." F. W. Borg. December 13th. (Complete.)

27,199. "Improved method of accelerating the excitation of electrical machines." Siemens Bros. & Co., Ltd. (Siemens Schuckertwerke G.m.b.H., Germany.) December 13th. (Complete.)

27,201. "Improvements in connection with electrostatic wattmeters and watt-hour-meters." E. Wilson. December 13th.

27,209. "An improved system of electrical distribution for railways, and method of operating same" J. H. Hallberg. December 13th. (Complete.)

27,211. "Improvements in protection of electric distribution systems." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 13th.

27,217. "Improvements in and relating to telegraphic transmitters and receivers." J. Esser. (Date applied for under Patents Act, 1901, May 2nd, 1904, being date of application in Germany.) December 14th. (Complete.)

27,246. "Improvements in electrical measuring instruments." Siemens Bros. & Co., Ltd., and E. A. Holmes. December 14th. (Complete.)

27,260. "Improvements in apparatus for electrode deposition." A. J. Betteridge. December 14th.

27,297. "Improvements in and relating to means for lighting and extinguishing gas lamps by electricity." G. G. Hiorgi. December 14th. (Complete.)

27,310. "Improvements connected with electric glow lamps." C. E. Abell. December 15th.

27,317. "Improved means of reflection in connection with electric and other lights." T. D. Jackson. December 15th.

27,348. "Improvements in electrical switches." G. Eason. December 15th. (Complete.)

27,353. "Improvements in electric controlling apparatus" Otis Elevator Co., Ltd. (Otis Elevator Co., United States.) December 15th.

27,399. "Improvements in electricity meters." W. Hamilton and Ferranti, Ltd. December 15th.

27,400. "Improvements in systems of electric motor control." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 15th.

27,401. "Improvements in electric motor control systems." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 15th.

27,402. "Improvements in maximum demand electric indicators." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 15th.

27,403. "Improvements in maximum-current indicating devices." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 15th.

27,424. "Device for magnetising iron by means of an alternate current and improvements in dynamo-electric machines." M. Walker. December 16th.

27,434. "Improvements in the construction of single and two-way electric switches." Clement Brown, F. Olai and Brown & Barlow, Ltd. December 16th.

27,437. "Improvements in, and relating to, arc lamps." G. M. Zingel, W. Wolf and A. Reiner. December 16th.

27,443. "Improvements in electric arc lamps, and carbons for same." A. Eckstein and A. E. Angold. December 16th.

27,444. "Improvements in electric switches." A. Eckstein and A. J. D. Krause. December 16th.

27,449. "Method and apparatus for electrostatic separation." W. Fairweather. (C. H. Huff, United States.) December 16th. (Complete.)

27,456. "Electro-magnetic ignition device for explosion engines." F. Lutz. December 16th.

27,475. "Improvements in electrical switches." W. R. Comings. December 16th.

27,479. "Improvements in, and relating to, inverted arc electric lamps." N. P. Andrew and T. Macduff. December 16th.

27,537. "Improvements in vapour electric apparatus." H. I. Wood. December 16th. (Date applied for under Patents Act, 1901, December 17th, 1903, being date of application in United States.) (Complete.)

27,588. "Improvements in means for transforming electric current." C. P. Steinmetz. December 17th. (Date applied for under Patents Act, 1901, December 17th, 1903, being date of application in United States.) (Complete.)

27,605. "Improved electric system of driving vehicles in an arena or course." E. E. Ehewess. December 17th. (Complete.)

27,627. "Improvements in and relating to portable electric conductors." A. Bergtheil. December 17th.

27,636. "Improvements in and relating to electric systems of train lighting." The Allgemeine Elektricitats-Gesellschaft. December 17th. (Date applied for under Patents Act, 1901, December 19th, 1903, being date of application in Germany.) (Complete.)

27,637. "Improvements in and relating to vapour electric apparatus." J. T. Dempster. December 17th. (Date applied for under Patents Act, 1901, December 19th, 1903, being date of application in United States.) (Complete.)

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1904.

Electric Block Signalling Systems. L. C. Werner. 707. January 11th.

Electric Light Fittings. Veritys, Ltd., and P. G. Ebutt. 1,128. January 16th.

Telephonic Apparatus. K. Hoflinger and K. Wolffhardt. 1,205. January 16th.

Party Line Telephone Systems. W. W. Dean. 1,242. January 18th. (Date claimed for patent under Patents, Act, 1901, June 15th, 1903, being date of application in United States.)

Electric Clocks. G. S. Tiffany and J. van Inwagen. 1,258. January 18th.

Electric Igniters for Explosion Motors. C. Ropiquet and A. Daveluy. 1,314. January 18th. (Date claimed for patent under Patents, Act, 1901, May 30th, 1903, being date of application in France.)

Method of and Means for Regulating Electric Motors. J. G. V. Lang. 1,371. January 19th.

Telephone Relay. B. Gati. 1,414. January 19th.

Processes for Manufacturing Electrodes for Arc Lamps. A. Blondel. 1,576. January 22nd. (Date applied for under Patents, Act, 1901, February 5th, 1903, being date of application in France.)

Apparatus for Obtaining a Flow of Electric Current in one Direction from an Alternating Current Source. P. C. Hewitt. 1,851. January 25th.

Trolley Heads or Collectors for Electricity. F. H. Hadfield, G. C. Wyman & Co. 2,279. January 29th.

Trolley Arms for Electric Cars. W. A. Daggett. 2,420. February 1st.

Electric Switches. G. Wright and H. M. Acly. 2,457. February 1st.

Brush Holders for Dynamo-Electric Machines. H. M. Acly. 2,458. February 1st. (Date claimed for patent under Patents, Act, 1901, January 31st, 1903, being date of application in United States.)

Compensating Systems for Alternating Electric Current Generators. E. E. F. Creighton. 2,459. February 1st.

Electric Light Fittings. G. Irving. 2,766. February 4th.

Electric Signalling Systems for Railways. J. B. Struble. 2,899. February 5th. (Date claimed for patent under Patents, Act, 1901, February 19th, 1903, being date of application in United States.)

Electric Railway Signalling Systems. H. E. Bradley and E. F. Bowen. 3,211. February 9th.

Prevention of Arcing in Electrical Apparatus. G. E. Blood. 3,251. February 9th.

Electric Switches. W. Duncan, R. MacDiarmid and E. B. Bates. 3,426. February 11th.

An Improved Combined Coin-Freed Clock Work Apparatus Chiefly Designed for Use in Combination with a Circuit Controller. T. D. Ingram and L. Phillips. 3,560. February 12th.

Dynamos. I. Deutsch. 3,882. February 16th.

Electric Switches. A. C. Reyrolle. 4,020. February 17th.

A Process of, and Apparatus for, the Generation of Electric Energy. H. J. Keyser. 3,913. February 16th.

Electrical Transformers. J. S. Peck. 4,357. February 22nd. (Date claimed for patent under Patents, Act, 1901, February 28th, 1903, being date of application in United States.)

Electric Switches. P. A. Spalding. 4,413. February 22nd.

Electric Controllers. A. C. Eastwood. 4,507. February 23rd.

Telephone Annunciator or Indicator Switchboard. A. Eckstein and F. G. Bell. 4,590. February 24th.

Electric Contact Breakers or Tremblers for Ignition Coils. S. R. Cohen and B. R. Cohen. 4,660. February 25th.

Electric Furnaces. O. Frick. 4,864. February 27th.

Method of Receiving Electrical Vibrations Utilising Electrolytic Coils. W. P. Thompson. (Gesellschaft fur drahtlose Telegraphie m.b.H., Germany.) 5,105. March 1st.

Supports and Guards for Conductor Rails of Electric Railways. H. L. Doulton and C. E. Morris. 5,227. March 3rd.